MACHINERY

May, 1911

MACHINING A MILLING MACHINE COLUMN

By FRED E. ROGERS*

THE prevailing practice of American machine tool builders is the use of jigs and fixtures for practically all the principal machining operations, and the leading concerns provide a jig or fixture for all drilling, boring, planing and milling operations whatsoever. The use of jigs insures interchangeability and greatly reduces the cost of quantity production. On that all are agreed, but the practice varies considerably as to form of jigs and the way they are employed. The box jig originally developed for manufacturing firearms, in which the part operated on is partly or entirely enclosed in a cast-iron box having a hinged cover or the equivalent, is the form commonly used for the smaller machine tool parts, but obviously the box jig becomes very heavy and cumbersome when applied to the larger castings such as frames, slides, etc., and while the box construction of the jig has certain advantages over all other forms, its cost, the space required for storage and other drawbacks have led the machine tool maker to the use of sectional or piece jigs, which are supported by the work itself, instead of enfolding and supporting the work. The piece jig, of course, is located and supported by a previously machined surface usually made either by planing or boring. An excellent example of simple but accurate piece jigs is the equipment used by Kearney & Trecker Co. of Milwaukee, Wis., for the manufacture of its well-known knee-type milling machines, and in the following article we have illustrated and described the jigs, tools and operations on a No. 3 column in their regular order.

An operation sheet is made up by the drafting and planning department for each part, in the form shown here, and accompanying the operation sheet is a drawing of the part, showing where the operations are to be performed as well as the dimensions and other data commonly given on shop working drawings. The operation sheet gives the order of operations, the tool-room number of the jigs and tools and their shelf locations in the tool-room. The drawing of the column, reproduced in Fig. 1, shows the position of the parts to be machined. They are indicated by reference letters and the same references are used herewith.

The first operation on the column is rough planing the face *A*, which is done on a Gray planer. Two tools are used in one tool-post on the roughing cut, as can be seen in Fig. 2. The cut is thus divided between two tools, the leading tool being set deeper than the following tool, of course. After roughing the front face, the column is cleaned and painted.

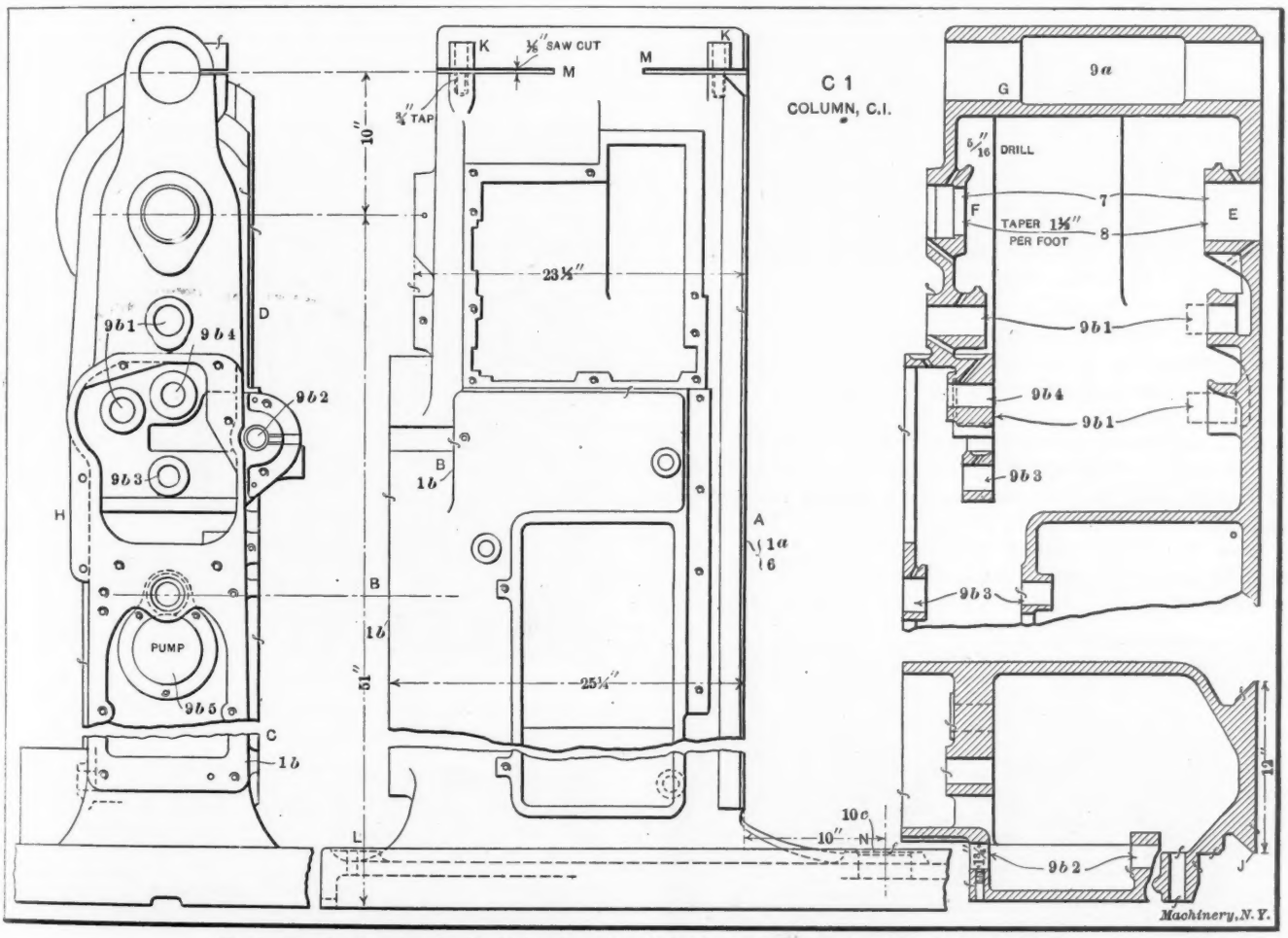

Fig. 1. Drawing locating the Machining Operations listed in the Operation Sheet on the Next Page

The rough planing operation not only relieves the strains in the casting, but it serves also as a thorough inspection of it. Should serious defects be found that cause rejection of the casting, the loss is not so great as it would be if the cleaning and painting had been done first. (See the following article describing the painting operations in detail.) The column is then returned to the planing department and the back of the column, *B*, and door frame *C* are rough and finish planed. See Fig. 3 for set-up on planer, tools, etc.

The fourth operation is milling the surface *D*, as shown in Fig. 4, and sawing the 1/8-inch slots *M* required for the overhanging arm clamps. (See Fig. 5.) These operations are designated as a and b on the operation sheet, both being milling operations on the same special machine—a larger size of the Milwaukee miller. The fifth operation is drill-

* Editor of MACHINERY.

ing the holes *K* and *L*. Filler pieces are slipped into the slots *M* before drilling, and after drilling, the holes are tapped and the clamp screws screwed down tight. This is done to prevent change of shape after boring the overhanging arm hole, which was found to take place if the slots were cut after the hole was bored. The column then goes to the planer for finish planing the surface *A*, Fig. 1. During the time that elapses between the rough planing of the face and the finish planing, the internal stresses in the castings are relieved and little or no change need be anticipated afterwards.

Form G-61 OPERATION SHEET C1

KEARNEY & TRECKER CO.

MACHINE No. 3 PART NAME Column PART NO C1
LAID OUT BY T.T./W.M. DATE 11/19/10 DRAWING NO C1

No	OPERATION	JIG NO.	Tool Box No.	Shelf No.	Machine No.	Speed	Feed
		1841		B			
1	(a) Rough Plane at A —	667	252	B			
2	Clean & Paint						
		1842		B			
1	(b) Plane at B B & C	1115	252	B			
4	(a)-Mill at D	2165	267	71			
	(b)-Saw at M M						
5	Drill at K K & L						
6	Finish Plane at A						
		1769	170	45			
7	Bore E & F	1850	170	47			
		1853	75	A			
8	Hand ream F	1850	75	A			
		566	72	37			
9	(a)-Bore G						
		613	73	37			
	(b)-Bore with Jigs	658	74	41			
		659	73	37			
		1609	254	24			
		742	107	40			
		723	174	23			
10	(a)-Drill at D & C						
	(b)-Drill at H	1573	191	50			
		1864	90	61			
	(c)-Bore & Face N	1860	255	A			
		1858	97	45			
11	(a)-Drill with Jigs at B	733	76	50			
		1747	74	41			
		729	76	50			
		860	107	40			
	(b)-Drill oil holes on Press						
12	Filler Paint						
13	Drill oil holes with portable Drills						
14	Scrape						

Operation Sheet listing All Operations on Milling Machine Column

The gages shown in Fig. 6 are used for testing the shape and dimensions of the vees and dovetail.

After the finish planing the column goes to an upright drill press to have the spindle holes *E* and *F* bored and reamed. It is clamped face down on a carefully leveled bed,

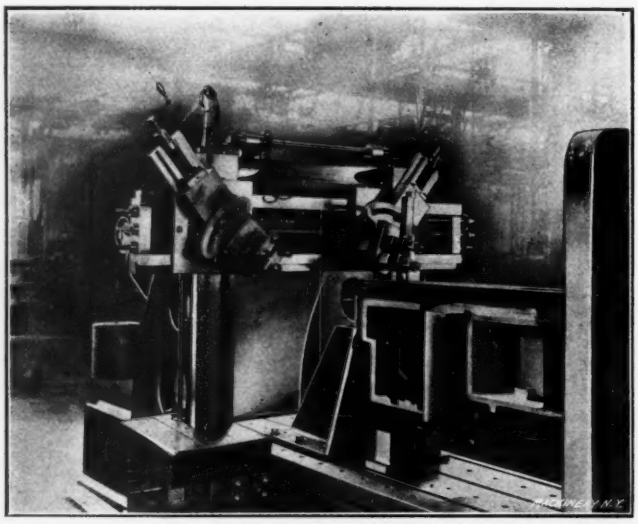

Fig. 2. Rough Planing on Face to take out Spring and inspect the Casting

Fig. 7; the boring-bar, of the form shown in Fig. 8, is supported at the bottom by a bushing that is located by the front face, the vee and the ledge that was milled in operation 4. The pin, bearing against the ledge, is shown near the base and in front of the opening in Fig. 7. The column, of course, must be accurately located under the drill press spindle inasmuch as the boring bar is aligned and supported at the upper end by the spindle that drives it. The straight and taper reamers and cutters for stepping out the taper hole are shown on a stand at the left with wooden base and top, in which latter a number of holes are bored for the reception of tool shanks. These stands, provided for holding boring

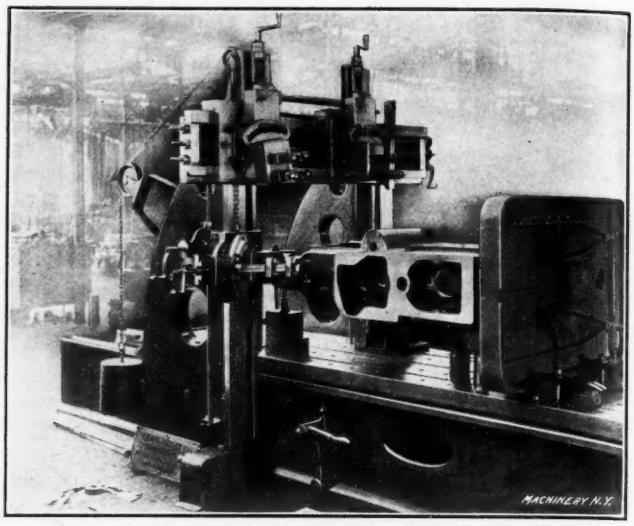

Fig. 3. Rough and Finish Planing Back of Column, Door Frame and Vertical Trip Slot

tools, reamers, drills, counterbores, etc., are shown supporting various tool equipments in a number of the illustrations.

After the spindle hole is bored and reamed, the column is

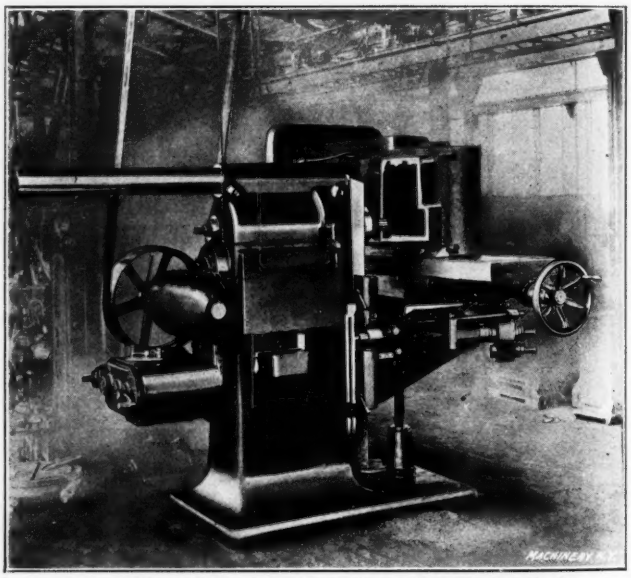

Fig. 4. Milling Edges of Opening into the Change-gear Cavity

laid down on its back and the ingenious hand reaming jig shown in Fig. 9 is put in place, as illustrated in Fig. 10. The

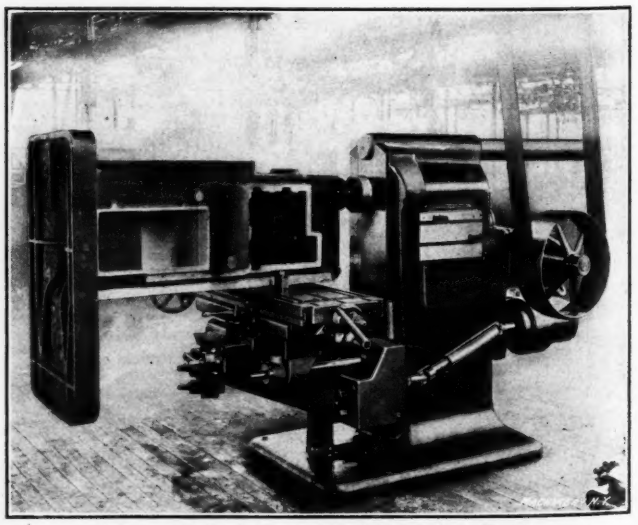

Fig. 5. Sawing Slots for Overhanging Arm Clamp

jig is supported by a narrow bearing in the spindle hole in the front and the abutment screws in the four points

of the spindle. These screws are set out against the inside walls of the column, the adjustment being made with reference to the column face by the straightedge and micrometer mounted on the end of the 18-inch arm. When the reaming jig is accurately set, the test bar is removed and the reamer and reamer bar inserted, as shown in both Figs. 9 and 11, the latter view showing the men at work reaming the back taper bearing for the spindle box. Of course, this operation is simply scraping the taper bearing to correct the slight inaccuracy of alignment that may have been found with the test bar.

Having bored and reamed the spindle hole square with the front face of the column, the following boring and reaming operations are done, using this hole as the starting point and means of location and alignment. Operation 9, displayed in Fig. 13, this being the boring of the arm hole, is also done under an upright drill press. The jig, which embraces the top of the column, is located by a ground bar with bushings fitting the spindle hole, and the boring bar is of the same form as that illustrated in Fig. 8. The arm clamp screws are set up, clamping the filling pieces snugly before this boring operation is started, the reason being, as before explained, to avoid changes of shape and alignment that were invariably developed if the slots were cut after the arm hole was bored. The general construction of this jig, bars, etc., is indicated in the sectional view, Fig. 12, which shows the jig in place; and also an end view of it.

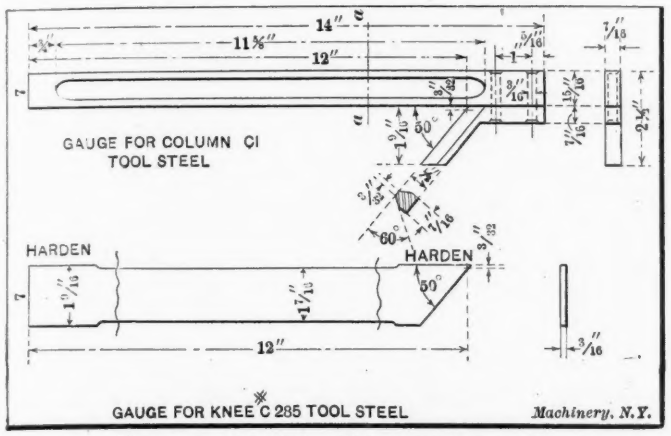

Fig. 6. Gages for Testing Column and Knee Vees

The subsequent operations under 9 are designated here as 9 b 1, 9 b 2, 9 b 3, 9 b 4 and 9 b 5, respectively. The operation 9 b 1 is illustrated in Fig. 14, and reference to Fig. 1 will show the reader more clearly where the holes are located and the nature of the work. The jig is located by the spindle hole and the milled surface *M*. As this hole is cut from the solid, a twist drill is used to open it. The accurate location of the column under the spindle is obtained by means of the plug shown standing at the right of the drill, this being placed in the spindle when the jig is aligned. The plug fits closely in the jig and the column and jig must be in close alignment before it will enter and pass through freely. The boring bar, facing tools, reamer and bushings for

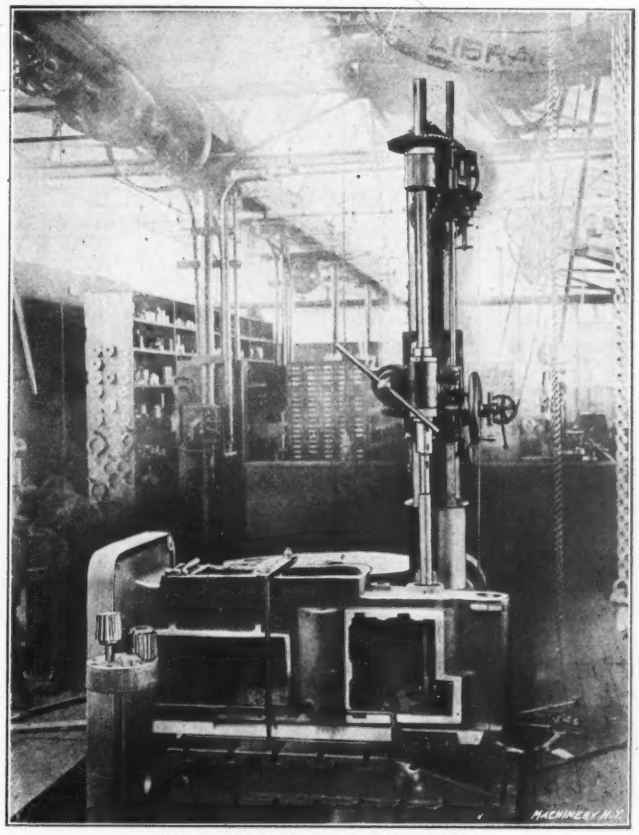

Fig. 7. Boring the Main Spindle Hole

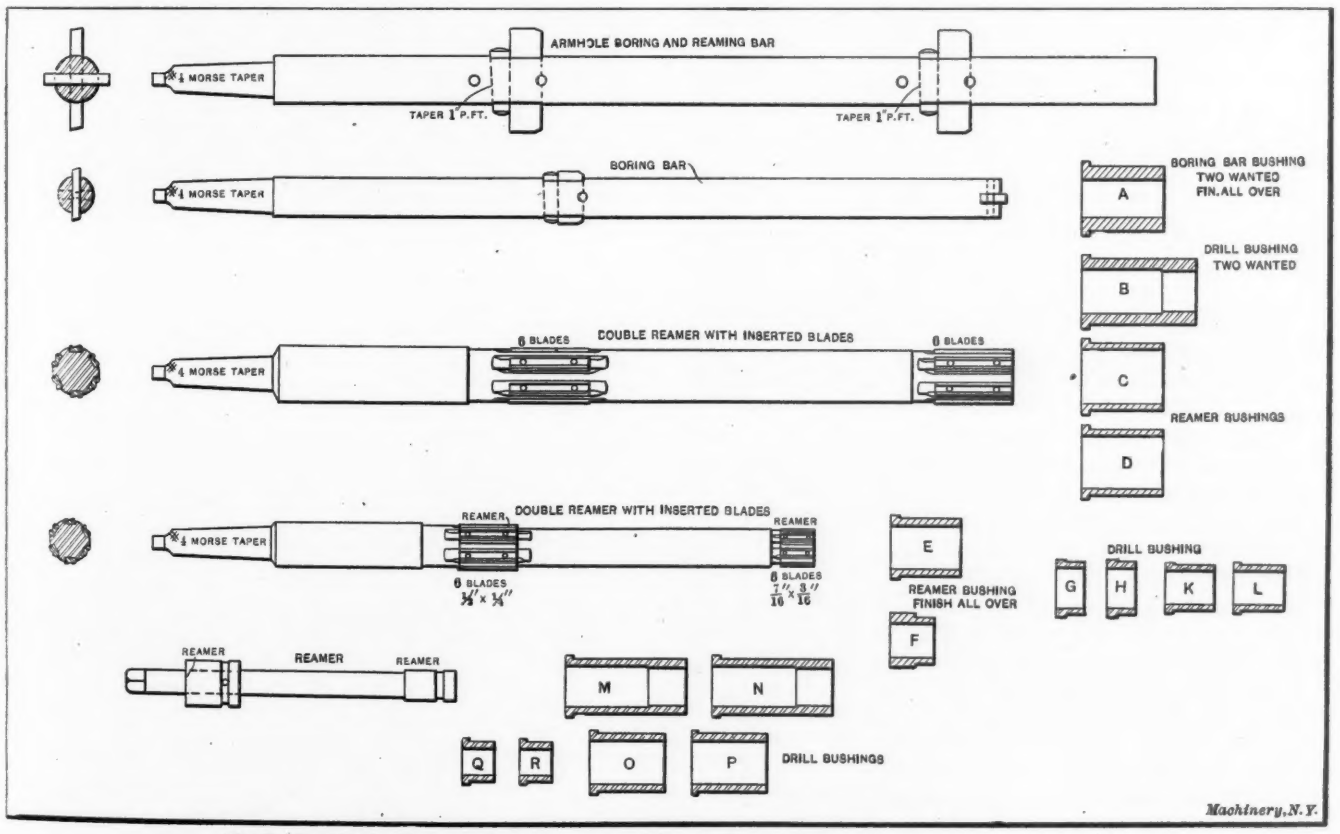

Fig. 8. Boring-bars, Reamers, Bushings, etc., constituting Part of Tool Equipment for Boring Column

the operation also appear in the illustration on the stand at the left, and the details of the reamer are given in Fig. 8. The small cast-iron ribbed plate leaning against the base, having three slots, is a convenient and reliable gage for controlling the depth of cut of the facing tools. This plate is laid

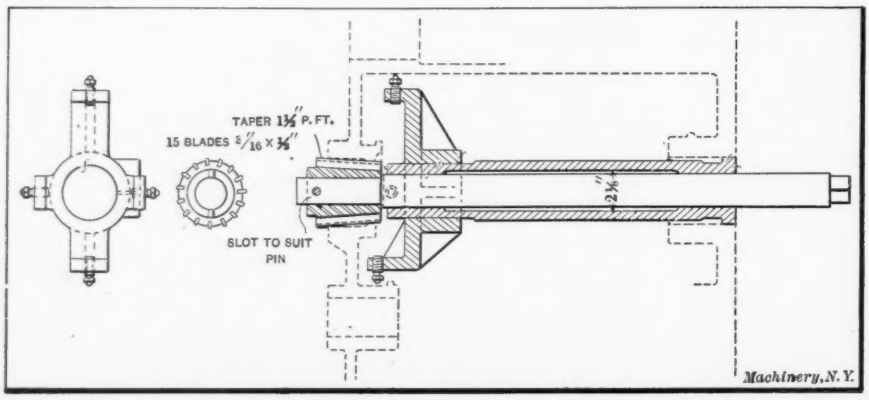

Fig. 9. Reaming Jig for Locating and Supporting Hand Reamer in Spindle Bearings

on the planed surface of the column with the sides of a slot astride the facing tool bar, and the collar on the tool limits the downward travel. Leather collars are provided for the boring bars to prevent chips falling into the bushing below and destroying the accuracy of fitting. These collars, though simple features, are very important in keeping the tools in first-class condition.

In Fig. 16 the column is seen undergoing operation 9 b 2, the location of which is indicated in Fig. 1. The bars and tools are at the left mounted in their stand ready for use, and the details of the jig appear in Fig. 15. The construction of this

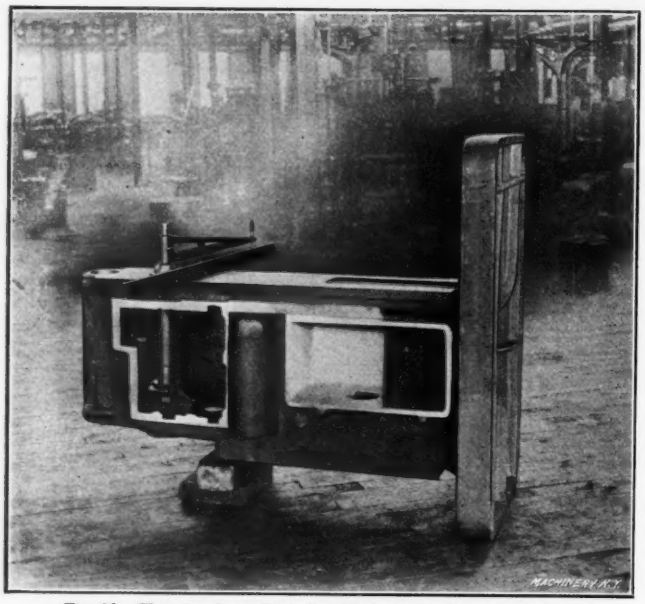

Fig. 10. Showing how Reaming Jig is set to Face of Column

jig is somewhat peculiar because of the necessity of inserting a supporting bar and clamping the jig to it after insertion. The jig, of course, supports the boring bar at the top and bottom.

Operation 9 b 3, seen in Fig. 17, requires the bars, reamers and facing tools on the two stands at the right; and the jigs and tools for operation 9 b 4 appear in Fig. 18. In Fig. 17 the bar in front inserted in the hole previously bored acts as a stop against which a pin in the jig plate abuts. The small holes in the jig shown in Fig. 18 for tap bolts are drilled under a radial drill, the important bearings only being bored under the upright drills.

Operation 9 b 5, illustrated in Fig. 19, is boring and facing the seats for the spur-geared pumps that circulate the lubricating oil to all the internal bearings, and the fluid for cooling and lubricating the cutters. The character of the operations is shown by the form of the tool in the drill spindle and the one lying on its side on the column, at the left.

Operation 10-a is also done under the radial drill, Fig. 20. The jig in place is located by the horizontal milled ledge and one vee. The jig for the door frame and the vertical trip strip are leaning against the jack and the column, and the tools for the operations are in the two stands at the left. Operation 10-c is boring the hole for the elevating screw and facing the boss, Fig. 21, in which a long bushing for the nut is fitted. The reason for not making this boss for the nut integral with the casting is that it would seriously interfere with planing the front face of the column.

Fig. 22 shows another radial drilling job, this being the tap holes for the feed-box and pulley bracket. This illustration shows the jig, standing on edge, that is used in operations 9 b 1, 9 b 3 and 9 b 4, and illustrates the principle of supporting and locating jigs by plugs fixed to the jig plates. The line illustration Fig. 23 gives further details of this jig.

Last but not least the operation 11-b, drilling the oil-holes,

Fig. 11. Hand Reaming the Spindle Bearings

completes the list of machining operations. Notwithstanding the fact that practically all have to be performed within limits of one-thousandth inch and some are difficult of access, the equipment is extremely simple. The peculiar internal construction of the column is due, of course, to the all-geared drive and automatic lubrication, the latter being an exclusive feature of the Milwaukee miller.

The tool equipment briefly described in the foregoing is

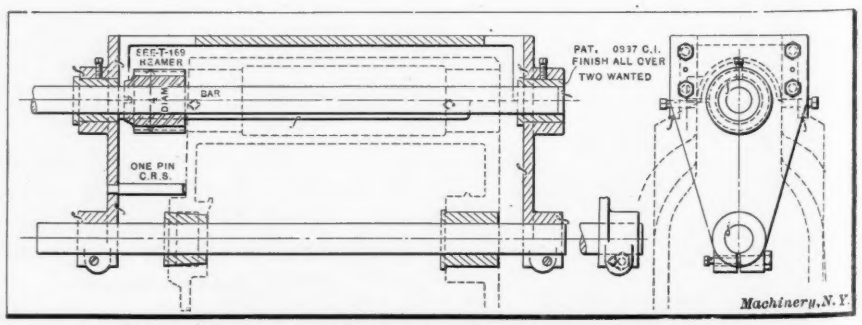

Fig. 12. Showing Construction of Arm Hole Jig and the Spindle Bar

of admirably simple design and is adapted for the use of skilled mechanics. In this respect it is at a disadvantage, perhaps, with the more costly and cumbersome box jigs that are

practically fool-proof. But users of these milling machines generally will not be sorry to learn that though they are the product of a highly developed manufacturing plant, plenty of good old-fashioned ideas still prevail here, as to the character of men and methods employed in doing work, that satisfy

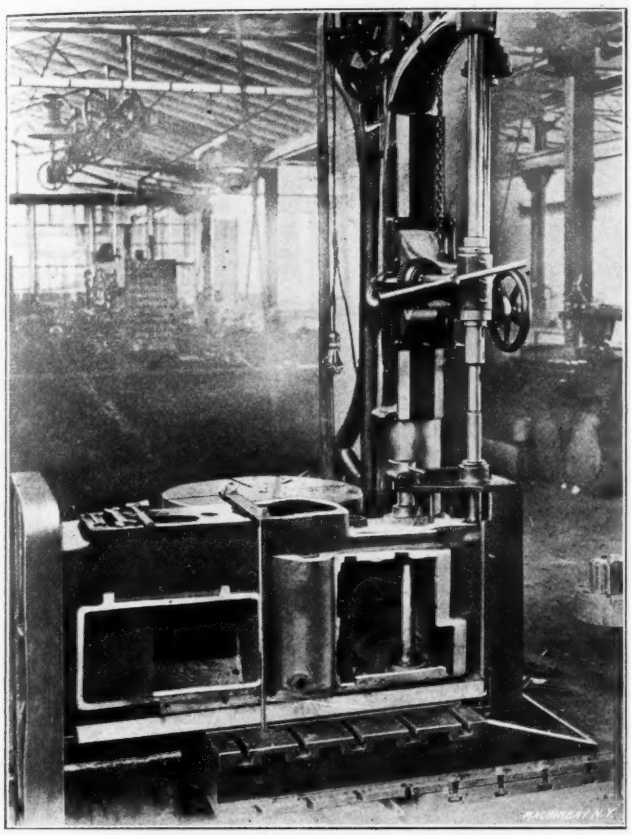

Fig. 13. Boring the Overhang Arm Hole. Clamp Screws are snugly set before Boring

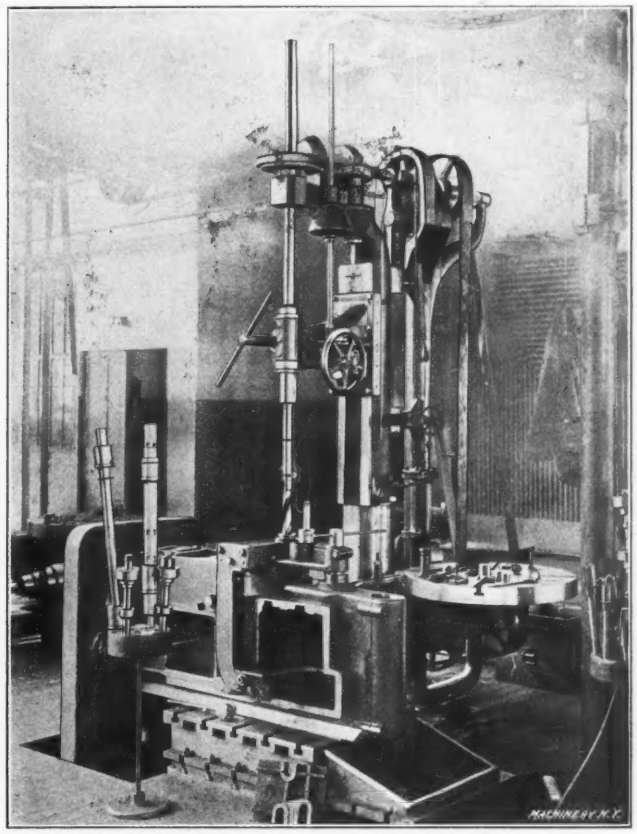

Fig. 14. Operation 9b1. Bar located by Spindle Hole and Milled Surface at Edge of Opening

the ideals of the two enterprising partners who have built up this flourishing business.

* * *

PAINTING MILWAUKEE MILLING MACHINES*

Most *good* mechanics at some time or other in their mechanical careers have been greatly impressed with the difficulty of finishing a machine or tool satisfactorily. In fact it may be truthfully stated that it is far easier for the average mechanic to *build* a good machine than to finish it in keeping with its use and purpose. The product of the individual is generally recognizable as "homemade" until he has acquired the faculty of carrying his work clear through the finished stage with that indescribable something known as "taste." Many of us who are not "strong on finish" take comfort in saying that it counts for little, and a machine will do its work just as well whether well painted or not. The truth is that finish, although something apart from mechanical excellence, is that which marks its climax, requiring both the skill of the mechanic and the taste of the artist to secure the most pleasing result. The effect on the intelligent prospective buyer is two-fold.

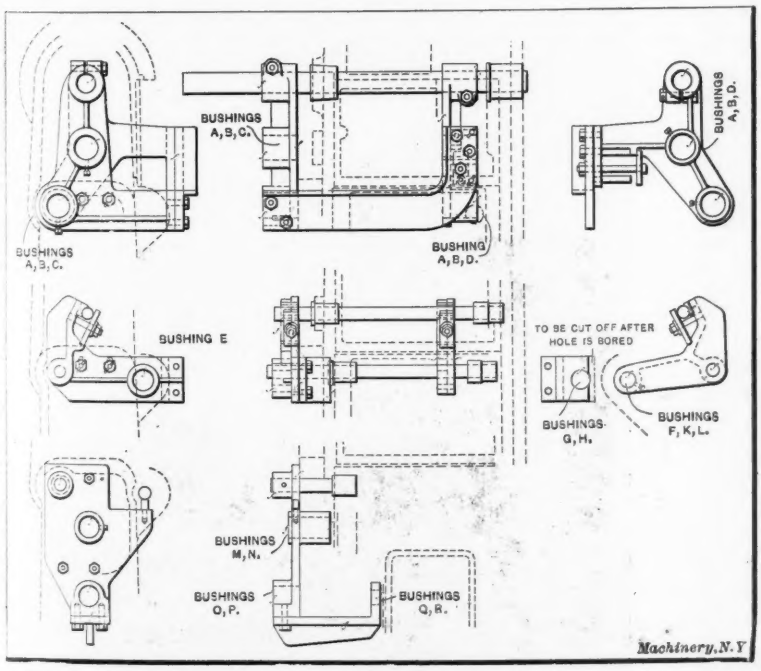

Fig. 15. Jigs for Operations 9b1, 9b2 and 9b3, respectively. See Fig. 8 for Bushings

It is not uncommon to hear a buyer of machine tools say that he does not care anything about how a machine is painted so long as the important parts and the general workmanship are satisfactory. While this man is quite correct in his choice—preferring a well-made to a well-finished machine—it is a noteworthy fact that the number of buyers making this distinction is steadily diminishing, and it is becoming generally understood that a manufacturer who exercises the care necessary to *finish* his machines nicely will be pretty sure to exercise the same care with the *details of construction*. The most cold-blooded buyer is affected favorably by a well-painted machine in spite of his blustering statement to the contrary—just as he is affected by the lines and distribution of the parts of the machine that go to make a harmonious design. This, however, is another story—how machine tools are painted by one successful concern.

It is strongly recommended that a beginner in the machine tool field pay close attention to the matter of good painting. In the early days of their venture both Messrs. Kearney and Trecker of the Kearney & Trecker Co., Milwaukee, Wis., makers of the Milwaukee milling machines, studied the problem carefully and did the work with their own hands, learning that proper materials was only part, and that painstaking care was needed at every step. Interested critics suggested that paint was the only good thing about these machines, but the man who bought had opportunity to test for himself, and the good painting was one of the

* For further information on the subject see: "Painting and Filling Machine Tools," April, 1908.

things that induced him to give the machine a trial.

Objection is sometimes made on the ground of cost but this will not hold good as the expense is far less on a percentage basis than it is in the case of a hay rake, and the added value to the user is just as great in one case as it is in the other.

At the solicitation of the editor the Kearney & Trecker Co.

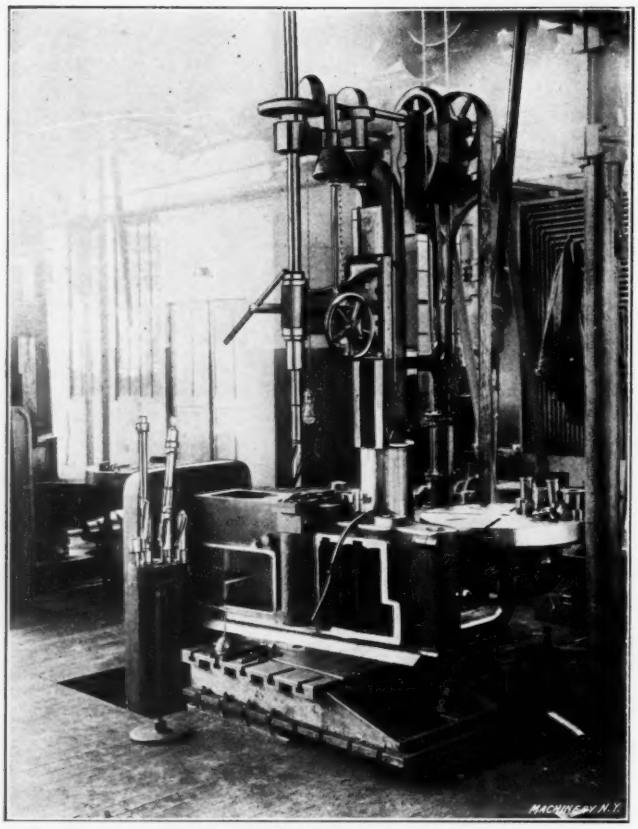

Fig. 16. Operation 9b2. Notice Compressed Air Hose—Compressed Air used to blow away Chips

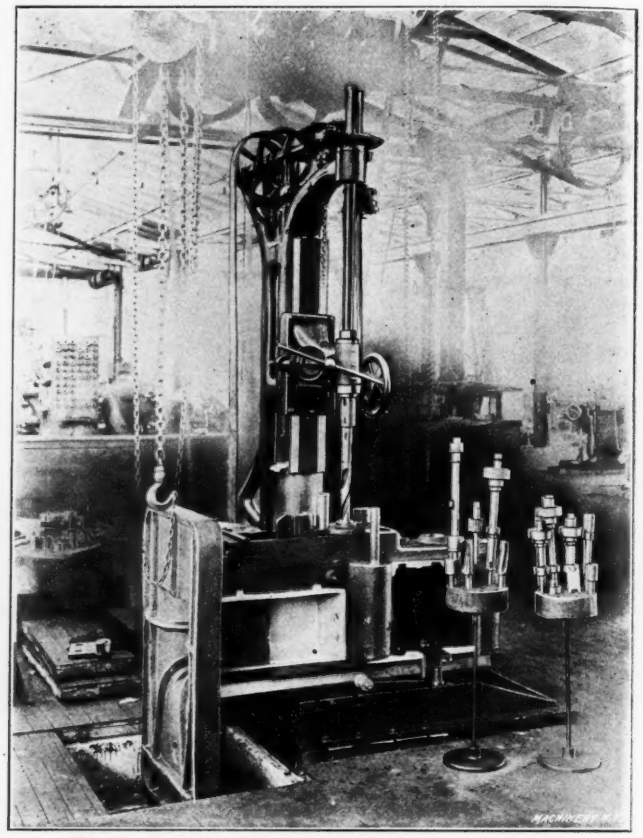

Fig. 17. Operation 9b3. Note the Reamers, Counterbores and Boring-bars

has given the steps of painting the Milwaukee milling machines, and the materials used. It should not be inferred, of course, that other paints cannot be used with equal success

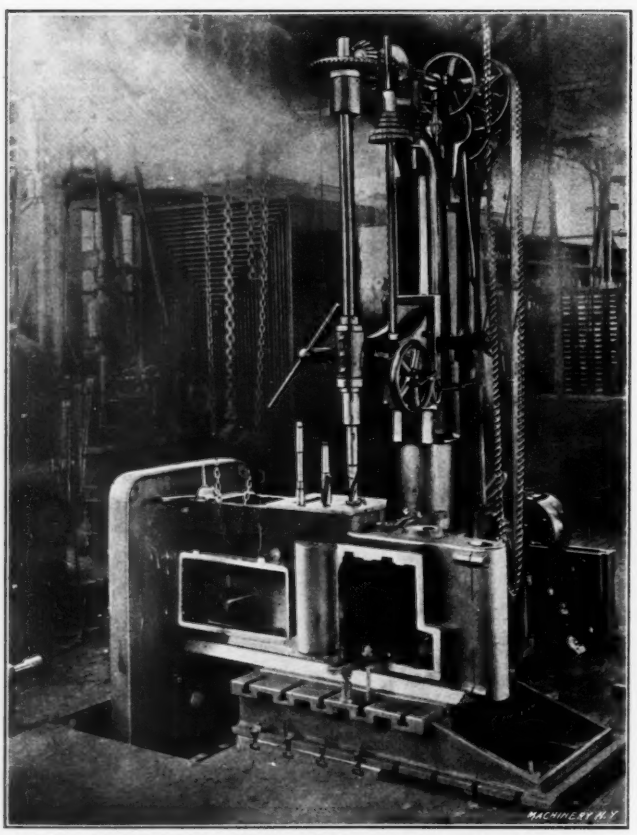

Fig. 18. Operation 9b4. Bars located from Holes produced in Operations 9b1 and 9b3. Depth Gage shown in Fig. 14 also used

but these are what have been found uniformly satisfactory after years of trial. The company emphasizes the fact that materials and tools do not give results without painstaking care any more than a scraper and surface plate in the hands of a careless workman will produce a flat surface.

1. Clean castings free from rust, graphite and oil.

2. Give castings one priming coat made with 16 pounds Patek Bros. No. 1470 paste primer and one gallon of turpentine. Brush on, and let stand over night.

3. Cardboard coat as thinly as possible with Patek Bros. No. 1427 machine filler, followed in 24 hours by a brush coat of the same. Allow this to dry for 24 hours.

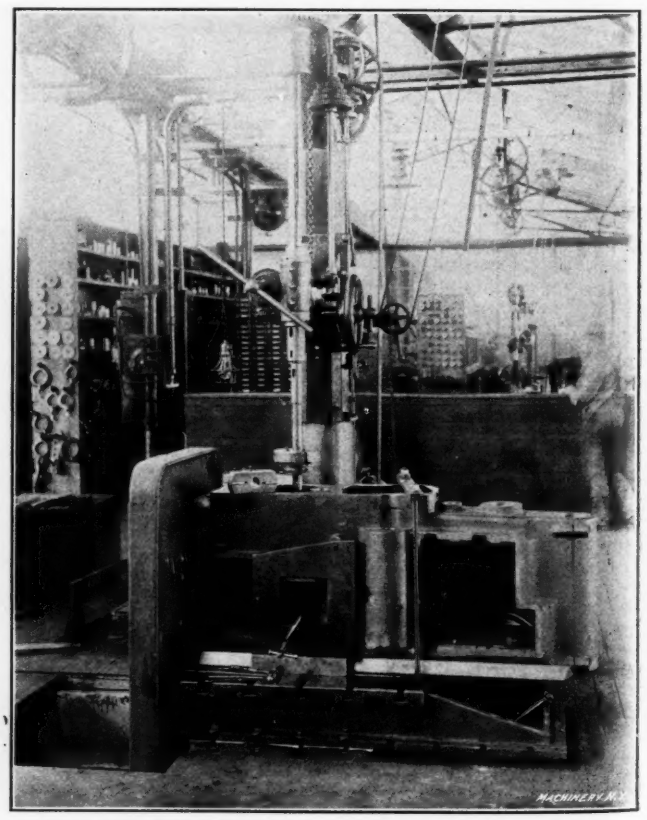

Fig. 19. Operation 9b5. Boring and Facing Pump Seats

4. Rub down with No. ½ emery cloth. Use water where dust is objectionable.

5. One coat Sherwin-Williams No. 7682 oil-proof paint.

When this coat is dry the parts are ready to be assembled.

6. Putty all imperfect places where the surface has been

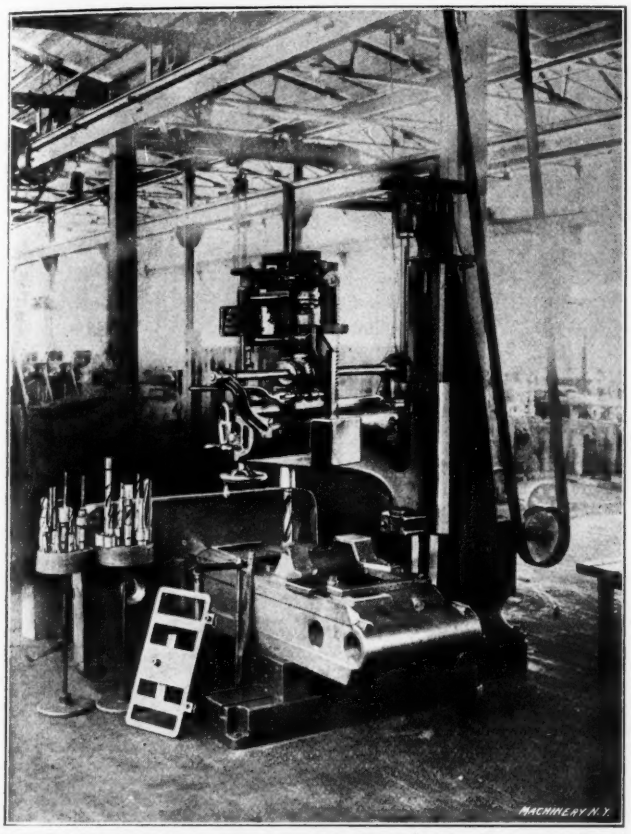

Fig. 20. Operation 10-a. The Jig on Top is located by Horizontal Milled Ledge on Side of Column. The Door Jig leans against the Clamp Jack

marred during the assembling operations, using hard drying putty.

7. Sand with No. 0 sandpaper.

8. Coat with grain alcohol orange shellac very thin—merely

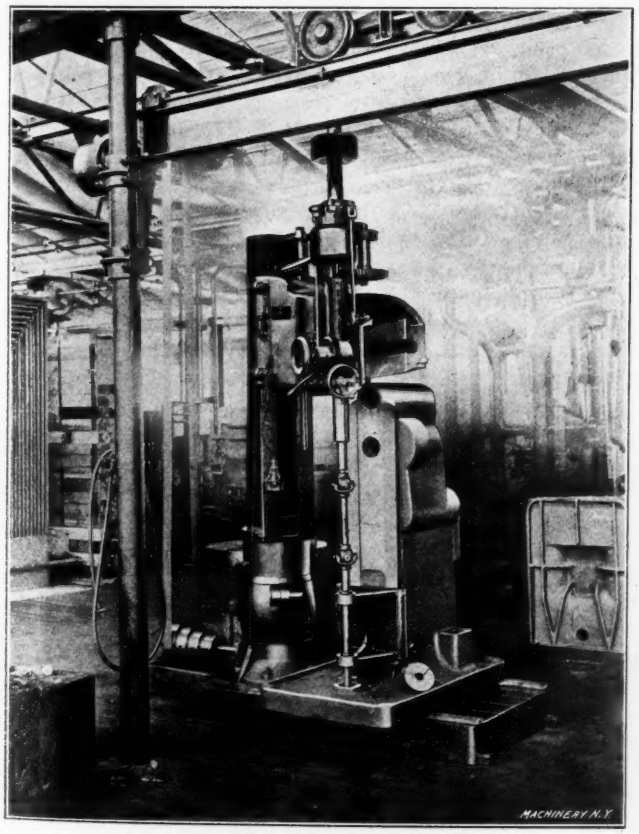

Fig. 21. Operation 10-c. Boring the Boss for the Elevating Screw Nut

a wash—to prevent any oil that may have soaked into the filler from interfering with the finishing coat.

9. One finishing coat Sherwin-Williams No. 7682 oil-proof paint. Use Fitch hair brush.

The large castings such as the columns are rough machined before any painting whatever is done. The reason is to find imperfections, if there be any, which would cause their rejection, before doing unnecessary work that would be lost in case a piece was scrapped.

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GERMAN EXPORTS AND IMPORTS OF MACHINE TOOLS

The exports of machine tools from Germany during 1910 aggregated 59,166 metric tons (1 metric ton = 2204 pounds).

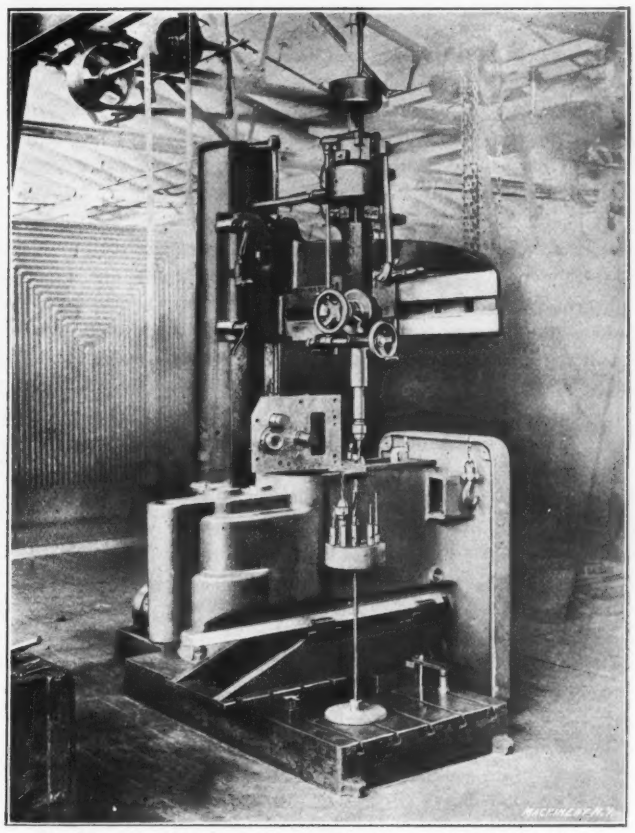

Fig. 22. Operation 11. Drilling Small Holes. Note Locating Plugs on Jig shown standing on Edge

This is the highest record so far obtained, the highest previous record being for 1908, when the exports amounted to 58,522 metric tons. During the past year Austria-Hungary

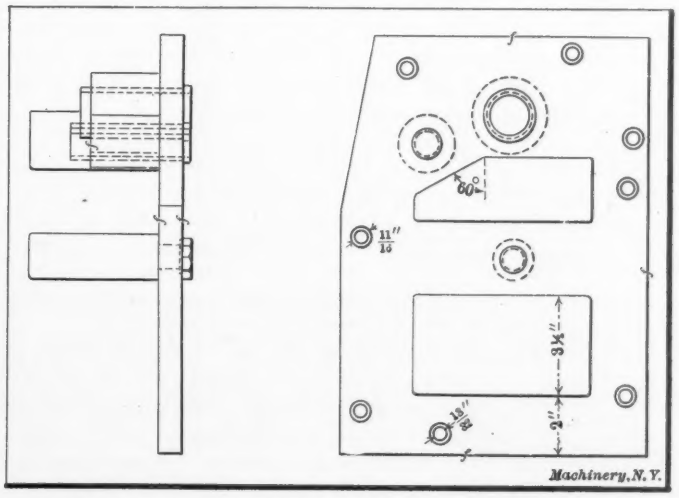

Fig. 23. Details of Jig shown standing on Edge in Fig. 22. Note Principle of Locating

was the best customer of German machine tools, one-fifth of the exports being to that country. Italy and France occupy the second and third places, respectively. Of the total imports of machine tools to Germany, the United States furnished about 60 per cent, or 3500 metric tons out of a total of 6000 tons. The imports of American machine tools to Germany were greater in 1910 than in 1908 or 1909, but considerably less than in 1906 and 1907. Ten years ago, in 1900, the exports of German machine tools were only 10,892 tons, while the imports to Germany were 6981 tons.

POWER-PRESS CONSTRUCTION—USES AND ABUSES

By HART PRESTON

Would you ever think of running your automobile or the engine in your shop without thoroughly lubricating it? Then why not give the power-presses in your shop the same attention? Would you ever allow your engineer to run your engine at 1500 revolutions per minute when the maximum safe limit of speed is but 900? Then why run at 250 revolutions per minute power-presses that are built to operate only at a maximum speed of 125?

How often do you permit operators to take a ¼-inch cut on a lathe having a maximum capacity of a ⅛-inch cut at the normal speed? Not very often! But how often, on the other hand, do you knowingly have the power-presses in your shop cutting the equivalent of three, four or five square inches of metal in spite of the ever-present fact that the machines doing such work were bought under a rigid guarantee of having a maximum capacity of one-half, or three-quarters of the strain to which they are subjected?

As in the selling, so in their use, power-presses should be looked after by men who know their goods, know how they are made, what strains each and every component part is designed to withstand and to what particular range of operations each press may be adapted. Yet the number of press-users is by no means limited who, although fully equipped for building their own power-presses, prefer (?) to have them built by press-builders whom they acknowledge as being expert mechanics in their line. But, notwithstanding these press-users assume to dictate what should be the shaft diameter, section of uprights, diameter of connection-screw, ratio and size of gearing, etc., on presses for certain work for which the builder has for an indefinite time furnished their competitors *standard* presses that have proved entirely satisfactory! It is a sad fact that although there is such a broad, unlimited field in this line of machine building, there are but

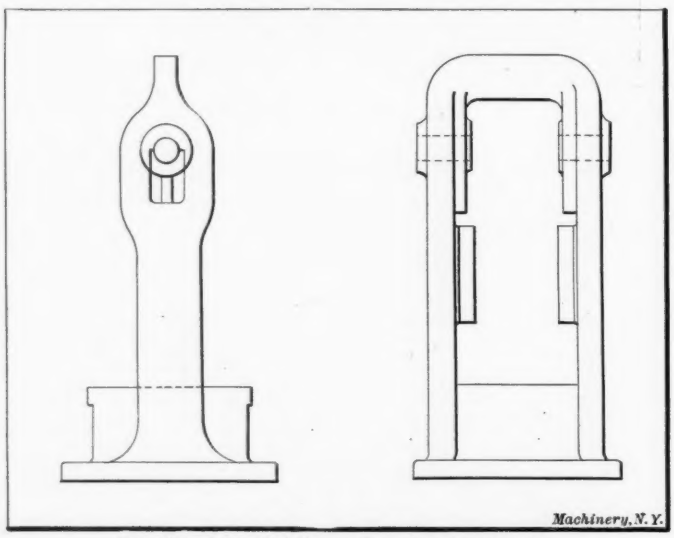

Fig. 1. Straight-sided Press—One-piece Construction

few men who can properly qualify as successful designers and builders of power-presses. Yet in spite of this, we find few, very few, power-press users who credit themselves with such indisputable knowledge and authority as to dictate "what's what" in power-press design, building their own presses or even as much as controlling any of the stock of any of the sheet-metal working machinery corporations.

As in other lines, there is strong competition in the press-building industry; the ever-increasing substitution of steel and other stampings and forgings for castings and solid metal and wooden parts brings to established press-builders an increased volume of business which at the same time is an incentive to others to engage in power-press building. These firms can be classified about as follows:

Builders of small presses only, for tin and other light work;

Builders of medium weight presses for producing brass, aluminum and the lighter grade of steel stampings, also for light forging work; and

Builders of presses for general sheet metal working and forging work, embracing anything from a tobacco tag to a seamless drawn steel barrel or bath tub, and in forging work, from a typewriter bar to the heaviest automobile axles.

It is to be regretted that with the stamping and forging business increasing by leaps and bounds in its scope, and hence almost compelling progressive press-builders to be constantly developing new and larger presses, there should be such a wide variation of opinion as to the safety factor to be observed in the construction of these heavy presses,

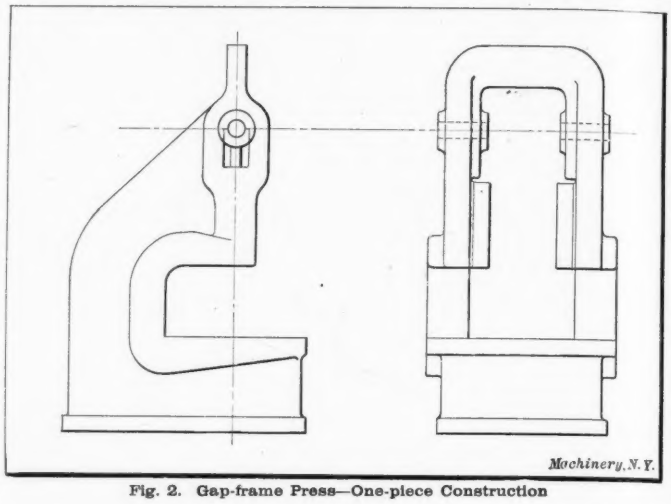

Fig. 2. Gap-frame Press—One-piece Construction

some manufacturers at times often basing this as low as 3 to 1, and others as high as 6 to 1.

In the scrap-heaps about the country we find:

Frames cracked at the shaft bearings, through not having sufficient metal at this point;

Uprights fractured just above the bed, clearly showing a frame out of proportion to the shaft and gearing;

Arches of frames broken, due to the same cause as the foregoing; and

Shafts twisted off entirely, due to the same cause, and thus necessitating the discarding of presses, as the frames may not be sufficiently strong at shaft-bearings to permit using shafts of greater diameter.

Giving the press-user the benefit of the doubt in the majority of these breakages, and assuming that these presses, when broken, were operating on work within their guaranteed capacity, it is to be readily seen that one cannot be too conservative in installing rationally designed and proportioned power-presses, particularly for heavy work.

In endeavoring to secure business one press-builder will lay particular stress on the large section of the uprights of his presses, another on the diameter of the shafts he furnishes and the quality of the steel used in them, while another (to humor a customer believing in the common fallacy of buying the greatest weight for the least money, a policy, however, that is not pursued in the purchase of any other machine tools) agrees to stiffen the bed and arch of a press to get this additional weight, although in doing so he knowingly unbalances his other proportions.

It is the general practice to use straight-sided presses as shown in Fig. 1 in preference to the gap-frame presses in Fig. 2 for the heavier classes of stamping and forging work. The grade of steel to be found in the shafts of the different makes of presses analyzes at from 0.30 carbon in the cheaper, to 0.55 carbon in the better, makes. On shafts with comparatively short strokes it is possible to determine very closely the maximum pressures that can be exerted with shafts of given diameters, and the frames must naturally be so proportioned as to withstand the full limit of the shaft pressure. The strain which a straight-sided frame will withstand is another point on which press-builders differ, some figuring this as great as 5000 and others as low as 2000 pounds per square inch of upright section. In the straight-sided frame, the pressure is transmitted in a straight line, and the design of this style of frame is such as to more uniformly distribute the pressure or strain over the entire section of frame than in the other style. The frames of the smaller presses of this style, that is to say, presses ranging in weight up to about 50,000 pounds, with the frames proper weighing approximately 25,000 pounds, are usually

cast in one piece and designated as "one-piece" frames. Frames above the weight mentioned are usually of the "built-up" type, shown in Fig. 3, having the bed, arch and uprights cast separately and tightly bound together by means of powerful steel rods, onto which the jam or check-nuts are shrunk in place while the rods are hot. With the elastic limit of these steel tie-rods definitely known, it is not difficult to determine the diameter of the rods required to lend sufficient stiffness to these built-up frames to fully and safely resist the maximum pressure of the shaft. However, as it is extremely difficult (due to the cooling and contraction of these rods) to tighten each of the nuts uniformly, the diameter of these rods should also be so proportioned to take care of any undue strain on any of the rods through having the nuts bearing tighter on one than on another and thereby subjecting it to a greater constant strain.

It is interesting to note here the rapid advancement being made only in very recent years on this style of construction. Unlike the purchase of a lathe (using this as an example only) in which the customer knows that the range of his work will be limited by the size of the lathe he installs, press-users often figure that instead of tying up the amount of money actually required for a suitable press for certain work, they

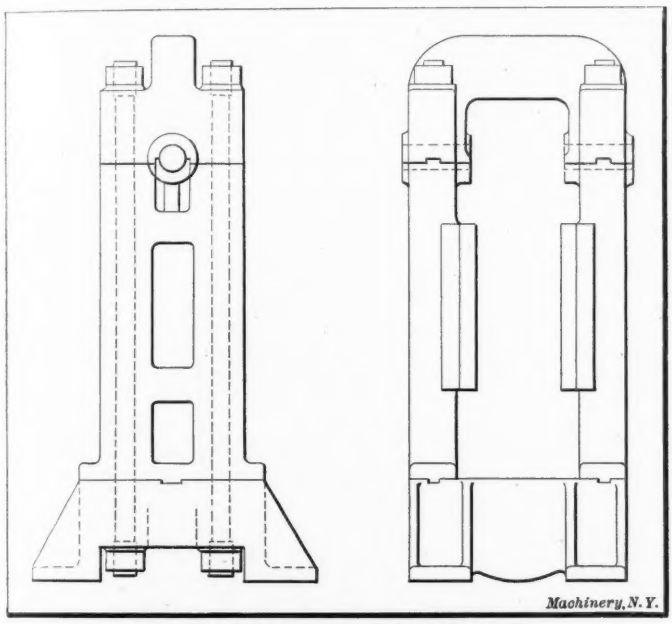

Fig. 3. Straight-sided Press—Built-up Construction

can afford to take a little risk and purchase a somewhat lighter press for the same job. To the discredit of some press-builders, such manufacturers were until very recently encouraged in this by the builder's offering to help the customer out by reinforcing (?) the lighter frame by shrinking steel tie-rods through it. True, they certainly stiffened the frame, but so much out of proportion to the shaft diameter that the writer has actually seen presses so constructed with the shafts twisted off entirely, close up to the main bearings.

From the above it will be seen that up to the point where frame castings are so large and heavy as to prevent castings being as dense and hard as are required, it is not only cheaper but safer to use frames without steel tie-rods, but with the uprights designed in proportion to the shafts and other parts. However, on the larger presses, where it is almost obligatory to use the "built-up" construction, and in which the full strain of the shaft is diverted from the uprights to the tie-rods, the rods should not only be of unusually large diameter to take any reasonable overload, but the nuts on them should also be of ample proportions and the bosses on the frames on which these nuts bear should also be properly proportioned. This is indicated in Fig. 3.

Carefully comparing the relative weights and proportions of the largest presses of this pattern, the number of each make in use and the work they are producing, the writer finds that while all of the three best-known builders observe about the same proportions, each has a different opinion as to the weak point, or that part of the press which should be so designed as to give or break before any other part, in the event of the press being operated beyond its capacity. One builder figures on the shaft bending, another on the connecting-sleeve breaking, and the third on the driving-pinion giving way. It may readily be seen that the last is not only the safest construction—as far as the possible damage to the press and dies in such accidents is concerned—but also the cheapest from the point of up-keep through time lost while the tools are out of commission in making the necessary repairs, for with the gear-guard arranged with suitable clearance for the broken teeth to fall out of the way, all that would ordinarily be required would be to carry an extra pinion on hand for just such an emergency.

Another feature which should receive equally as careful attention is the clutch, which is, in reality, the heart of a power press. Various types of friction clutches, as well as block or jaw clutches, are recommended by the different builders, and while a well-designed, practical block clutch may operate with entire success even on the larger sizes of presses, a properly-designed friction clutch with friction and braking surfaces of proper proportions is not only equally as efficient but preferable on these presses, particularly on presses requiring a uniform, constant pressure (for deep-drawn and similar work) which, of course, can be obtained with a block clutch only through a portion of the travel or stroke of the shaft. The friction clutch is also more efficient for reducing and drawing operations, for testing and trying-out dies, and as all properly designed friction clutches can be started or stopped at any point of the stroke (some, however, more quickly than others), this style of clutch is preferable in case of accidents due to dies not being properly set, getting more than one blank into the dies at a time, or other causes.

Another feature is the ratio of gearing and pitch of teeth. As in the safety factor for other vital parts of presses, we find there is an equally great difference of opinion on the ratio of gearing and the pitch of teeth. However, on several leading makes of large presses of about equal weight and capacity it has been proved that with these presses running at the comparatively slow speed at which they must be operated in view of the large and heavy blanks to be fed into and removed from the dies, it is the wiser plan to use gearing of large diameter, with the diameter of pinion and ratio of gearing designed to deliver the maximum efficiency of the balance-wheel running at its safe limited speed of about 3500 feet per minute, rather than to be compelled to run the latter at a greater and unsafe speed because of the use of gearing of a lower ratio and coarser pitch, which must necessarily be lighter, smaller in diameter, less powerful and requiring greater driving power.

Other important details in the proper design and construction of power presses, particularly in the larger sizes, are:

Long slides, with gibs or ways also of ample length to properly support and guide the slide, particularly on long-stroke presses.

Main and crank bearings of shafts should be as long as possible, with the main bearings extending inward as far as possible toward the cheeks of shafts to more rigidly support them.

Connection-sleeve and screw should be amply large to easily withstand the full safe working-pressure of the shaft.

All bearings throughout the entire press should have ample means provided for a constant, unchecked flow of properly-distributed lubrication.

Various press-builders will at times give customers data on "shearing stresses" to be used by them in determining the pressure required for certain blanking or shearing work. These formulas, however, should be used most conservatively, for when used to figure other work such as forming, embossing or swaging they cannot and should not be used as the basis for determining the pressure required to perform these operations, inasmuch as, outside of ordinary blanking and shearing work, the pressure required for the various operations on stamped and forged steel work can only be definitely ascertained by actual "trying-out," combined with good, thorough tests and experience.

CARTRIDGE MAKING—3

METHODS EMPLOYED BY THE DOMINION CARTRIDGE CO., LTD., IN THE MANUFACTURE OF SHOT SHELLS

By DOUGLAS T. HAMILTON*

A sheet of paper is in itself insignificant, but when passed through a series of apparently simple operations its transformation is sometimes marvelous. Possibly no product of paper bears out this statement to a fuller extent, than does the shot shell as now made. This consists simply of a sheet of paper formed into a tube of the required length, capped with a brass head holding a detonating agent, and then filled with powder and shot separated by wads. At the completion of these operations, a cartridge is evolved which is a general favorite with game hunters. While a shot shell does not in

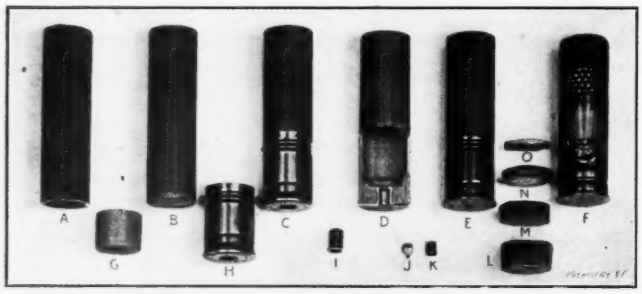

Fig. 37. The Component Parts of a Shot Shell before and after Assembling

the true sense of the term contribute to the highest welfare of the civilized world, nevertheless the processes employed by th Dominion Cartridge Co., Montreal, Canada, in its manufacture are extremely interesting.

The shot shell to be described is shown in its initial stage in Fig. 38, where *A* is the paper sheet 0.0075 inch thick by 14 5/16 by 10 3/4 inches; *B* is the sheet rolled into a tube; *C* is the tube cut into shell lengths; and *D* the trimmings. The sheet *A* is made thinner at the edges *E*, being 0.005 inch thick, so that when rolled into a tube, a smooth joint will be formed. The component parts of the shot shell dissected and assembled are shown in Fig. 37, where *F* shows the interior arrangement of the loaded cartridge. The manufacturing operations employed in making all the various parts shown will be described, except those for the anvil and primer shown at *J* and *K*, respectively. In this article Figs. 5, 8, 18 and 27, which appeared in the April and March installments, will be referred to.

Rolling and Drying the Tubes

The first operation in the manufacture of a shot shell is the forming of the sheet of paper into a tube, as shown at *A*

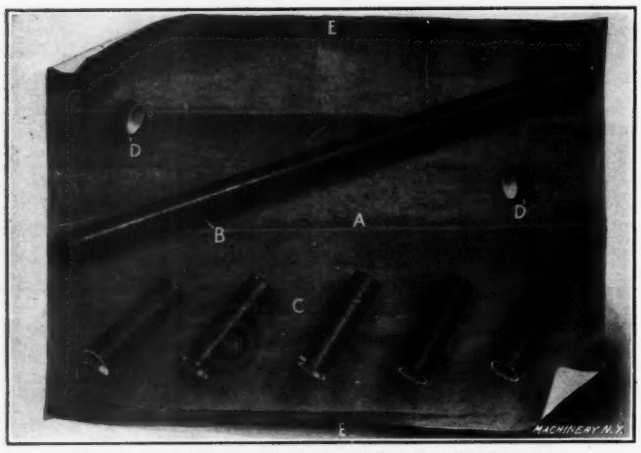

Fig. 38. Initial Stages through which a Shot Shell passes

and *B* in Fig. 38. This rolling operation is interesting, and the machine in which it is accomplished is shown in Fig. 40. A clear idea of the mechanism of this machine cannot be obtained from the illustration as it is of a rather complicated construction, but the principle on which it works is as follows:

The paper sheets, which are in pack form about 12 inches deep, are placed in a rack held on a carriage located at the rear end of the machine. The carriage on which the packs of paper are located is raised by a screw, which, in turn, is operated by a feeding mechanism. This feeding mechanism is so set that when a number of sheets have been withdrawn, a finger held on a horizontal shaft connected with the raising mechanism is tripped, and the raising mechanism operates until the carrier is raised to a sufficient height to continue the feeding operation. The sheets are withdrawn by two small rollers which travel over the pack, pick one sheet off at a time and place it on two rubber belts rotating on four pulleys. These belts carry the sheet from the pack to the table *A* located in front of the pasting and carrying rolls.

In withdrawing the sheets from the pack, they are separated from each other by a gaging mechanism, which allows only one sheet to pass through at a time. Supposing, however, that this gaging mechanism is not set correctly and that more than one sheet passes through; then when the sheets are carried to the table *A*, they will not pass under the arm *B*, as this arm if raised to a height greater than the thickness of one sheet will stop the feeding mechanism.

The sheet is fed to a stop *C* fastened to the table, and when located in this position is carried from the table to the carrying roll beneath the pasting roll *D*, by two rubber belts which also rotate on pulleys, and are located at right-angles to the belts that carry the sheet from the pack to the table. The pasting roll is corrugated, so that the paste will run freely along it and be distributed evenly over the sheet. The paste is pumped from a tank *E* through a pipe *F* to the pasting rolls, a pump being supplied for this purpose. The pasting and carrying rolls draw in the sheet, and at the same time

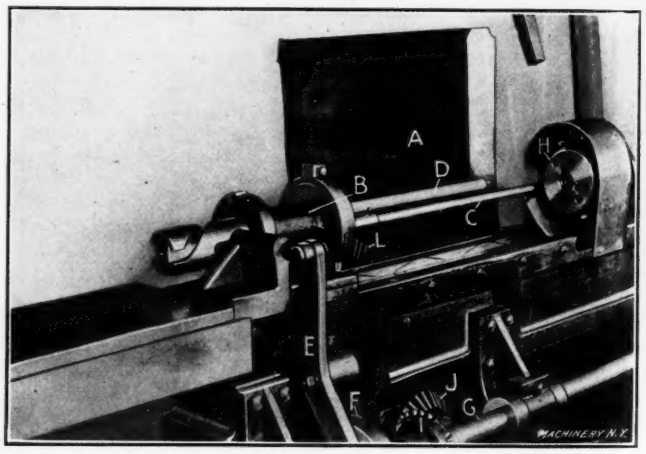

Fig. 39. Automatic Machine for Sizing the Tubes to the Correct Diameter

spread the paste over it. As the sheet passes through, it travels on a rack on its way to the rolling arbors.

The method of rolling the tube can be seen by referring to the diagrammatic view Fig. 43. Here *A* is the pasting roll and *B* the carrying roll. The roll *B* is cut away so that the circumferential distance from *C* to *D* equals the width of the sheet. This provision is made so that another sheet cannot be drawn in until the one on the arbor is rolled and the arbor indexed. The carrying roll and rolling arbor mechanism are so timed that the rolling arbor makes a sufficient number of turns to complete the tube and index before another sheet is drawn in. The sheet is drawn in over the grate *E*, which consists of brass strips about 1/16 inch thick and 1¾ inch wide, located beneath the rolling arbor when in position for rolling the tube. These rolling arbors *F* and *G* govern the inside diameter of the tube.

When the paper is located on the grate it is driven forward by the carrying roll *B* and comes in contact with the rolling arbor before it leaves the rolls. As it passes the vertical center line of the arbor *F*, the flappers *H* which are rubber strips fastened in a roller *I* and rotating in the direction of the arrow, flap the paper up against the rolling arbor. The rolling arbor at the same time is driven in the direction indicated, and carries the paper around, thus forming it into a tube. As soon as the tube is completed, the indexing mechanism is

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operated, the arbor *F* being carried to the top and the arbor *G* brought down in position for rolling.

The tube which has been rolled is now located on the arbor and has to be removed. This is accomplished by a bushing located on the rolling arbor back of the tube, and connected to a rack by a short arm. This rack is driven by a spur gear, which when operated moves it along, thus carrying the bushing and stripping the tube from the arbor. While one tube is being stripped from the rolling arbor, another tube is being rolled, so that there is a continuous rolling operation. The indexing mechanism is operated by a cam *G* (Fig. 40), which through a lever *H* having teeth cut in its upper end meshing with a gear (at the rear of the ratchet-wheel *L*) on the arbor *I*, rotates the disk *J* carrying the two rolling arbors. The rolling arbors are located in the correct position by means of the pawl *K* and ratchet-wheel *L*. The method of driving the rolling arbor when in position for rolling is more clearly shown in the tube cutting machine, Fig. 42.

The tube as it comes from the rolling machine is wet and in a plastic condition, due to the moisture of the paste, thus

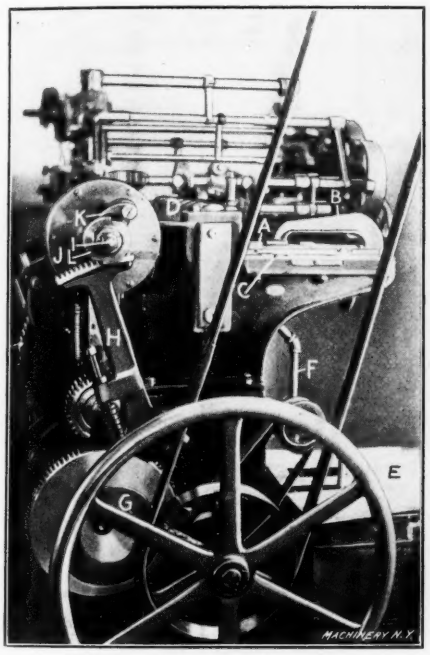

Fig. 40. Automatic Tube Rolling Machine

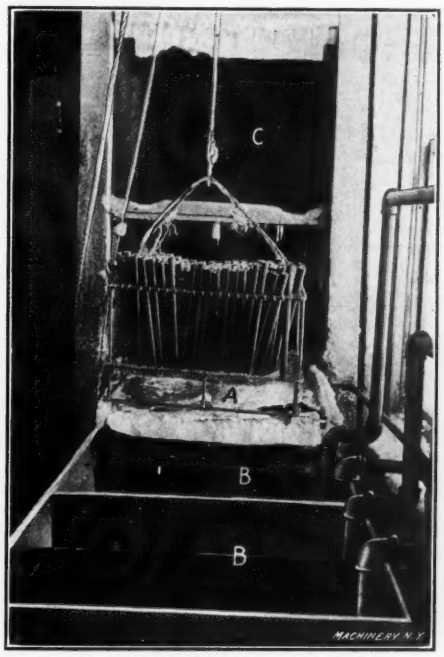

Fig. 41. Waterproofing Tanks and Drying Cupboards

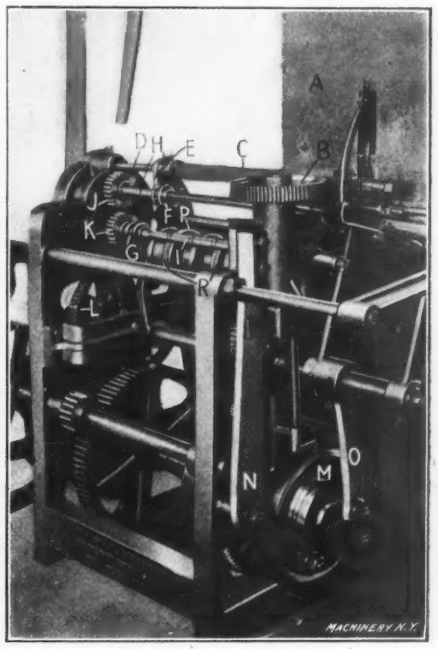

Fig. 42. Automatic Tube Cutting Machine

making it necessary to dry the tube, so that the paste will harden and make it stiffer. This is accomplished by putting the paper tubes in a wire basket, and placing the basket in a cupboard heated by steam. This dries the paste very quickly and produces a shell which is extremely stiff, considering the material from which it is made.

Sizing and Waterproofing

When the tubes are dried sufficiently they are ready for sizing. This operation is accomplished by passing the tube through a die which is rotated at a high rate of speed. Lard oil is furnished to the die by a pipe, so that the tube is well lubricated and stripping is avoided. The use of lard oil also extends the life of the die. As one tube is being sized, that is, being forced through the die on the sizing arbor, another tube is being located on the empty sizing arbor.

The sizing machine, shown in Fig. 39, is automatic in its operation; all that is necessary in the way of operating is to place the tubes in the hopper *A* parallel with the spindle of the machine. From this hopper they pass down an inclined slide into a pocket. The tube is held in this pocket as it comes down the slide, and is stopped at the rear end, so that it cannot be forced out of the pocket when the arbor is being inserted in it. The tube is taken from the pocket by the empty sizing arbor at the same time that the arbor holding a tube is being forced through the die, which is held in the head *H*. In the illustration the slide *B* carrying the sizing arbors *C* and *D* has retreated from the die, and is in position for the arbors to be indexed.

The tubes before sizing are slightly larger than the finished size, and as they are forced through the die they expand somewhat and are stripped from the arbor. This machine is provided with a hollow spindle, so that the tubes pass through it and drop into a box. The arbor indexing mechanism is operated through a lever *E* actuated by a cam *F* held on the rear driving shaft *G*. The carriage carrying the arbors *C* and *D* is advanced by a large bevel gear *L* meshing with a rack attached to the arbor slide. The bevel gear *L* is driven by the main driving shaft *G* through bevel gears *I* and *J*.

After the shells are brought to the correct size they are waterproofed, so that they will resist moisture, which is necessary to preserve the powder; as those familiar with cartridges know, powder will not explode when in a wet condition. The waterproofing operation consists in putting the tubes into a wire basket *A* shown in Fig. 41, and then immersing this basket with the tubes in it in one of the tanks *B*. These tanks contain paraffine wax, which is heated and is kept in a liquid state by steam pipes passing into the tanks. The tubes are kept in this waterproofing solution until coated thoroughly. The basket is then removed from the tanks and put into the cupboard shown at *C* at the rear of the tanks, in which steam pipes are located for drying the tubes.

Cutting to Length and Inserting the Base Wad

The next operation to be performed on the tubes after sizing and drying, is cutting them to the length required for the shell. This is accomplished in an automatic tube cutter, shown in Fig. 42. The method of putting the tubes on the arbors in this machine is similar to that described in regard to the sizing machine shown in Fig. 39. The tubes are put into the hopper *A*, from which they come down a slide into a pocket, where they are located in position for the arbor to enter them.

The ejecting mechanism used on this machine is the same as that used in the tube rolling machine shown in Fig. 40. Here the ejecting mechanism is more clearly shown. The gear *B* driven from the main driving shaft through bevel gears, meshes with a rack *C* which slides on an arbor *D*. The ejecting finger *E* also slides on the arbor *D* and is connected to the rack. The lower extremity of this finger is bent, and fits in grooves formed on the ejecting bushings *F* and *G*, when rolling arbors *H* and *I* are in position for stripping the cut tube. The method of driving the cutting arbors on which the tube is held, is also similar to the mechanism used for rotating the rolling arbors in the tube rolling machine shown in Fig. 40. The arbors *H* and *I* have spur gears *J* and *K* fastened to them, which when the arbor is in position for cutting the tube mesh with a gear *L*. This gear, in turn, is driven by the main driving shaft through spur gears which gives it the correct speed.

The method of holding the paper tube on the arbor while cutting is interesting, and is shown in Fig. 44. When the arbor is rotated to the cutting position, the shaft *Q* carrying the tube cutters *P* is gradually advanced toward the tube by means of a cam. As the shaft *Q* advances, the soft-rubber bands *R* come in contact with the tube, acting as a driver, and thus preventing the tube from rotating on the arbor or moving longitudinally along it. The shaft *Q* rotates at the same speed as the cutting arbors *H* and *I*—when in the cutting position.

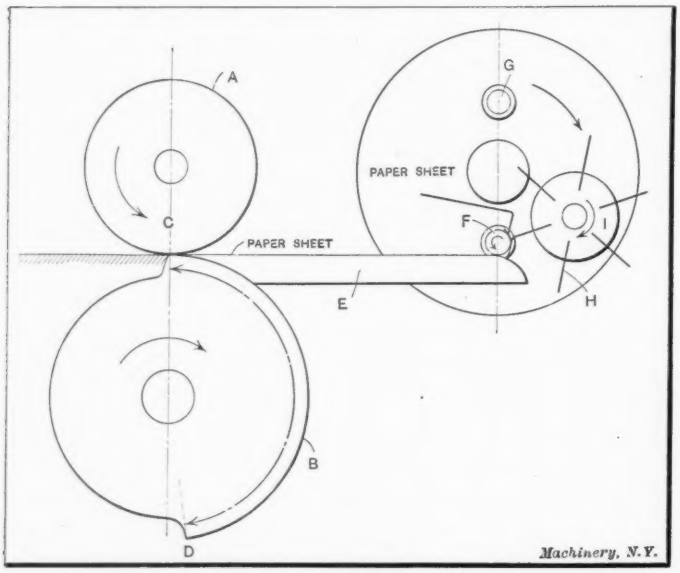

Fig. 43. Diagram showing how the Tube is rolled

The cutting arbors *H* and *I* are provided with grooves *S*, so that the cutters *P* will not come in contact with the arbor when they pass through the walls of the tube. The cutters *P* are plain disks made from tool steel, hardened, and ground on the faces P_1. It will be noticed from a study of the illustration that the cutters are so located, that the faces P_2 are in line with the edge of the grooves *S* in the arbor, but are not facing the shoulder. The reason for this is that as it is necessary to bevel one end of the shell to facilitate the putting on of the brass cap, the beveled edge P_1 on the cutter presses the tube against the arbor and acts as a beveling tool.

Referring again to Fig. 42, the ejecting and feeding mechanism is operated by the face cam *M* through levers *N* and *O*. While a tube is being cut, another tube is being placed on the empty arbor. This machine is entirely automatic in its operation and cuts the long tube into five different pieces, and also trims the ends as shown at *D* in Fig. 38.

Now that the tubes are cut into shells of the desired length, they are ready for the insertion of the base wad shown at *G*, in Fig. 37, which forms the head of the shell. This operation is accomplished in the hand-operated machine shown in Fig. 45. The paper for the heads is cut into strips of the correct width in another machine. These strips, which are in the form of a roll, are put in the circular box *A* which has a lid on top of it. The strip is brought out of the slot *B* in the box, and inserted in a slot in an arbor enclosed in the outer chuck *C*. This arbor is slightly smaller than the diameter of the battery pocket.

When the strip is inserted in the arbor, the machine is started by operating the lever *D*, and shifting the belt from the loose to the tight pulley. The strip is wound in the bushing *C*, which is of the correct size, and when this bushing is filled, the strip is cut by the sharp edge *E*. The shell *F* is now placed in the holder *G* and the handle *H* operated, carrying the shell toward the bushing. The bushing *C* is forced back by the carrier *G*, thus exposing the base wad and allowing it to be inserted into the shell. The handle *H* is again operated and the shell with the base wad inserted in it is withdrawn. While this is a hand-operated machine, it is marvelous how quickly these base wads can be wound and inserted in the shell.

Expanding, Piercing and Beading the Brass Heads

The shell is now in the condition shown at *B* in Fig. 47, and is ready for the brass cap to be placed on it. The cap which covers that portion of the shell enclosing the powder, is made from brass, and is received in the form of a cup as shown at *A*, Fig. 48. No drawing or trimming operations are performed on these caps previous to the expanding operation, as they are already drawn and trimmed to the exact length. The machine in which these caps are expanded is shown in Fig. 49. The operator places them mouth up in bushings *A*, twenty-four of which are held in the ratchet-dial *B*.

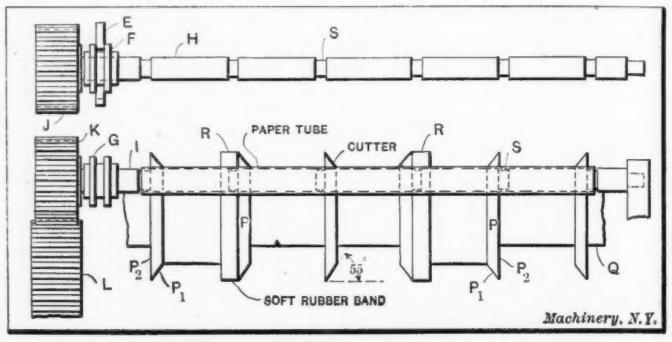

Fig. 44. Diagram showing how the Paper Tube is cut to the Desired Lengths

As the caps pass successively under the expanding punch *C* they are expanded. This punch consists of an outer shell which is split and held on a tapered punch by two coil springs wound around it. The expanding punch shown at *C* is what is called the "starting" punch. Another punch on the same principle, but not shown, is held in the ram of the press, which finishes the expanding of the head. The expanding operation is accomplished by the outer split sleeve sliding up on the tapered punch, which increases its diameter, so that the lower end, which is of the desired shape, is enlarged and forces out the sides of the head. The bottom of the bushings *A* are enlarged in diameter to allow the cap to be expanded.

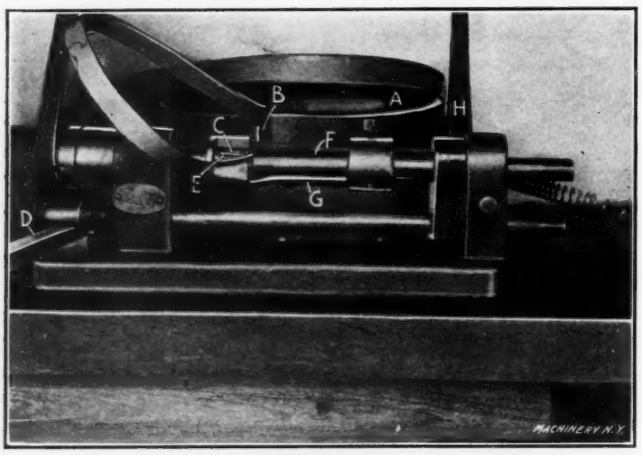

Fig 45. Machine for Winding and Inserting the Base Wad in the Shell

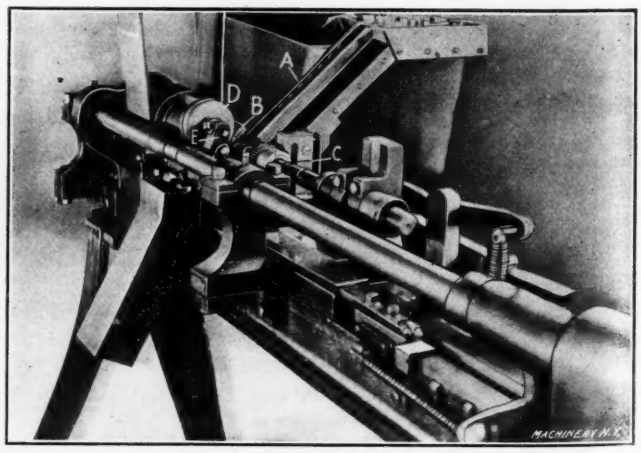

Fig. 46. Machine for Beading the Brass Caps

The cap now passes to the punch *D* which enters it, flattens the head, performs the stamping operation and pierces the hole, forming a seat for the battery pocket. The hole in this head is not pierced but is forced up, no die being used for cutting the material away. The shape of the cap after this operation is shown at *B* in Fig. 48. The stamping is done by a die having raised letters, so that the impressions are sunk into the head of the shell. This stamp is made with a hole in it, in which the piercing pin is located. As the cap passes around to the punch *E* it is flattened, and on further movement, the knock-out pin forces it out of the bushings into a chute, from which it drops into a box. After expanding the heads, the caps are taken to the beading machine shown in Fig. 46, which is of the semi-automatic feed type. The operator places the caps in the slide *A* with the mouth facing the head of the machine. As they come down this slide they are located in a pocket, from which they are carried onto a rotating arbor *B* by a half-bushing held on the shaft *C*. The beading is accomplished by a circular tool *D* which is not rotated, but is held stationary to the carrier *E*. This carrier advances when the cap has been located on the arbor, and the tool *D* forms the beading. The condition of the cap after the beading operation is shown at *H* and *C* in Figs. 37 and 48, respectively.

Assembling the Brass Caps and the Paper Shells

The brass caps and the paper shells are now transferred to the assembling machine shown in Fig. 50, where the cap is placed on the paper shell. Here the paper shells are placed on pins *A*, sixteen of which are held on the ratchet-dial *B*. Dies *C*, which are a good fit for the shell, are also held in this dial. The brass caps are placed mouth up on a friction-dial located at the rear of the machine, by another operator. This machine requires two operators to look after it, although one operator can feed the caps to two or three machines. As the paper shells are placed on the pins *A* in the dial *B*, they pass successively under the punches *D*, *E*, *F* and *I*. The spring punch *D* seats them partially on the pins, while the punch *E* seats them correctly. As the shell comes beneath the punch *F*, the cap is placed on it.

The cap is removed from the dial at the rear, by means of fingers held on the plate or carrier *G*. This carrier is held on the shaft *H* which is rotated by a friction gear, driven by a rack held to the ram of the press. The plate *G* swings through an angle of about 180 degrees, and lifts the cap from the dial by means of the fingers, transferring it to a position over the shell, where it is seated by means of the punch *F*. The punch *I* seats the cap firmly on the shell, and on the continued movement of the dial, the shell is transferred by the pick-up *J* from the pins to the chute *K* through the hollow spindle *L*. The pick-up mechanism is held rigidly to the ram of the press and travels up and down with it. The condition of the shell after this operation is shown at *C* in Figs. 37 and 47.

Heading—Forming the Base Wad and the Brass Cap to the Correct Shape

In the machine shown in Fig. 50 the brass cap and shell were only assembled but were not flattened; neither was the base wad formed to the correct shape. These operations are accomplished in the heading machine shown in Fig. 51. Here the shells are placed on pins, fourteen of which are held in the ratchet-dial *A*. Bushings *B* are also held in this dial, for forming the brass caps. As the dial is rotated, the shells pass successively under the punches *C* and *D*. The punch *C* seats the shell down on the pin, and the punch *D* forces it into the die *B*, flattening the head and forming the base wad.

The punches which are held in the dial *A*, are made to form the base wad into the shape shown at *D* in Fig. 47. This shape is given to the wad when in a dry condition. The shells are removed by the pick-up *E* which passes over the head of the shell, after it has been lifted from the die by the wad-forming pin. The knock-out motion is actuated by the rod *F* held to the ram of the press. This rod *F* operates a mechanism which forces the wad-forming pin up, thus raising the shell out of the dial to a sufficient height for the pick-up to grip it. This pick-up is operated in a similar manner to that shown on the verifying machine, Fig. 27.

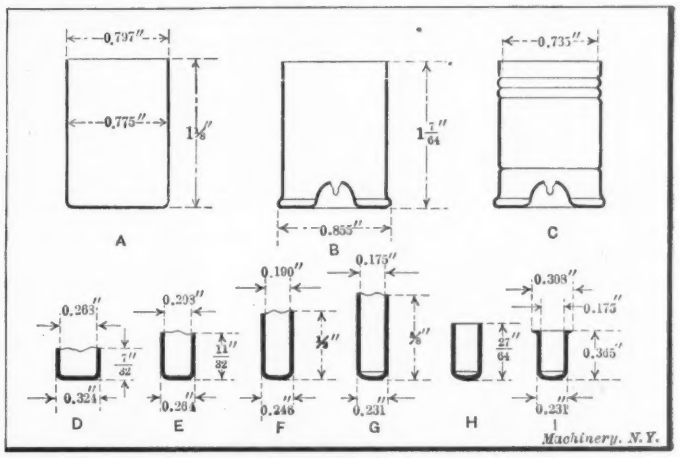

Fig. 48. Stages through which the Brass Cap and the Battery Pocket pass before Assembling

Drawing, Trimming and Flanging the Battery Pocket

The battery pocket which is used in the No. 12 gage Imperial shot shell is received in the form of a cup as shown at *D* in Fig. 48. This cup passes through three drawing operations as shown at *E*, *F*, and *G*, which increases its length to about ⅝ inch, and reduces its diameter from 0.324 to 0.231 inch. A drawing press similar to that shown in Fig. 5 is used for the drawing operation, and this cup also passes through the annealing, washing and drying operations. When drawn to the required length, as at *G* Fig. 48, the shell is taken to the trimming machine shown in Fig. 8, where it is trimmed to the desired length as shown at *H*.

The next operation is to flange the mouth, as shown at *I*, so that the pocket will have a head, which will seat properly in the brass cap of the shell. The flanging operation is performed in an automatic machine which is shown in Fig. 52. This machine is equipped with an automatic feeding device which is on the same principle as that used on the trimming machine shown in Fig. 8. The battery pockets pass from the

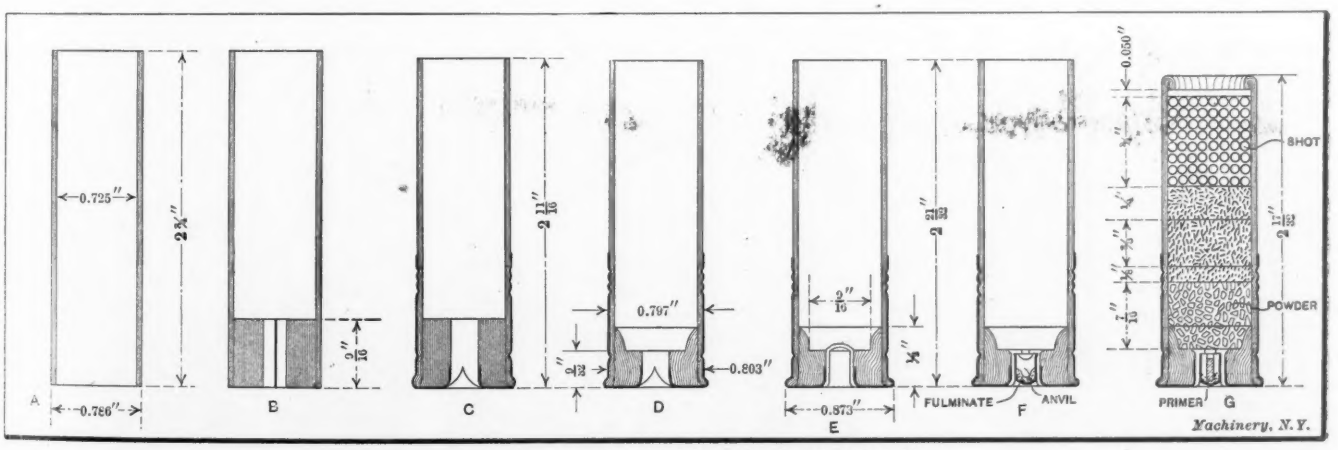

Fig. 47. Transition from the Cut Tube to the Finished Cartridge

hopper *A*, through a tube located at the rear of the machine to the carriage *B*. This carriage is actuated by levers and cams from the main crankshaft, and carries the pocket from the tube to the flanging dies where the flanging is accomplished by the punch *C*, held in the ram of the machine. An ejecting mechanism operated by the lever *D* ejects the pocket out of the die when it has been flanged, and deposits it in a box.

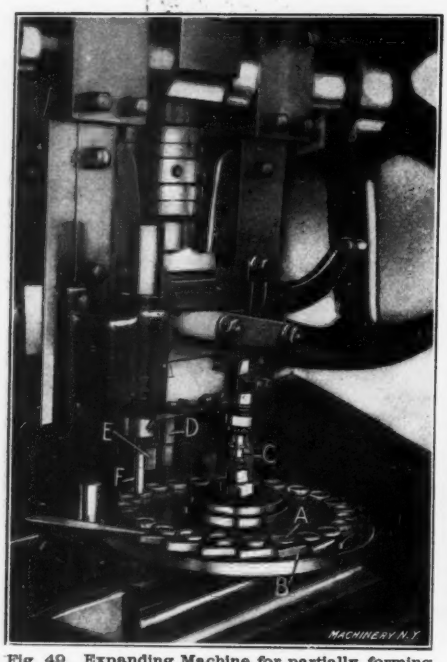

Fig. 49. Expanding Machine for partially forming the Head on the Brass Cap

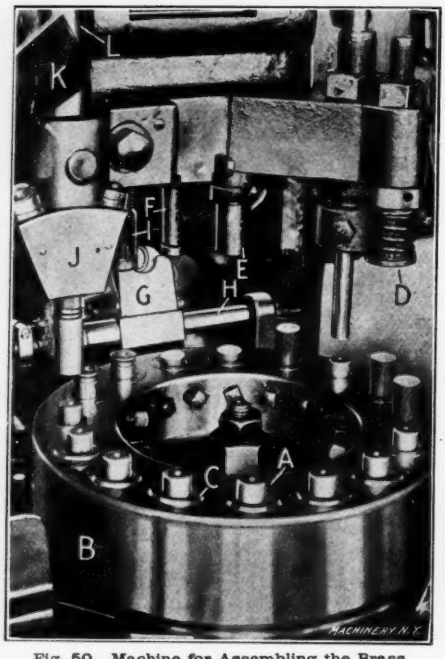

Fig. 50. Machine for Assembling the Brass Cap and Paper Shell

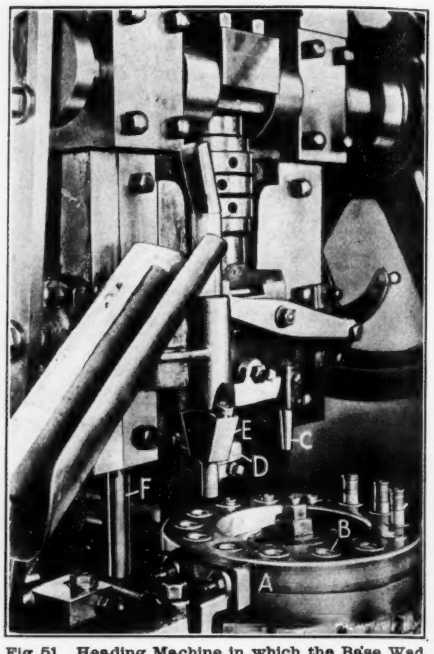

Fig. 51. Heading Machine in which the Base Wad and Brass Cap are formed to the Correct Shape

Inserting the Battery Pocket in the Brass Cap

Now that the battery pocket is flanged, the next operation is to insert it in the brass cap. This is accomplished in the assembling machine shown in Fig. 53. The shells are placed on the pins *A*, held in the ratchet-dial *B*, and pass successively under the punches *C*, *D* and *E*. The punch *C* forces the shells down on the pins, while the punch *D* seats them down correctly. The punch *E* sizes the hole in the head of the shell, thus making it ready for the insertion of the battery pocket.

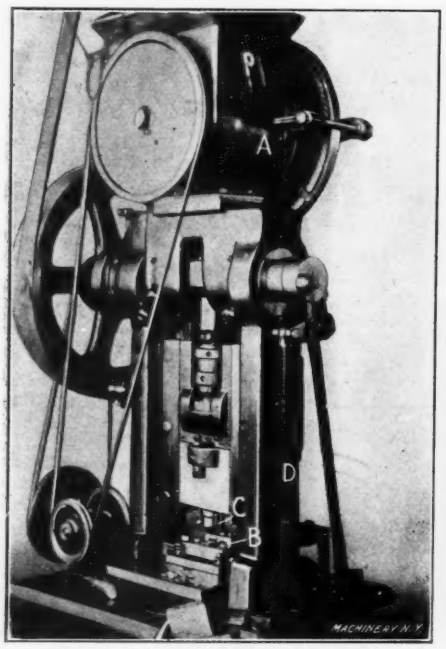

Fig. 52. Automatic Machine for Flanging the Battery Pocket

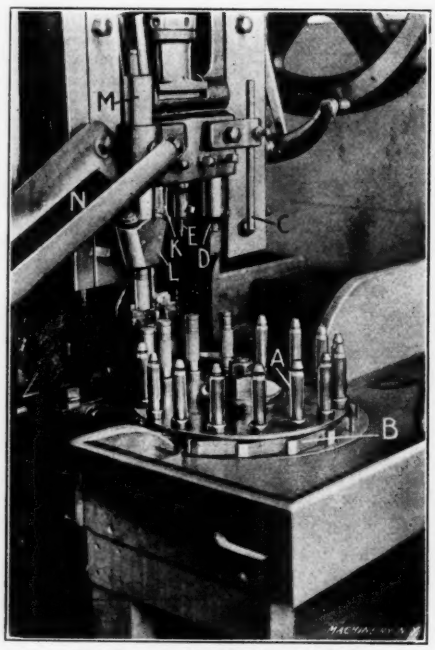

Fig. 53. Machine for Inserting the Battery Pocket

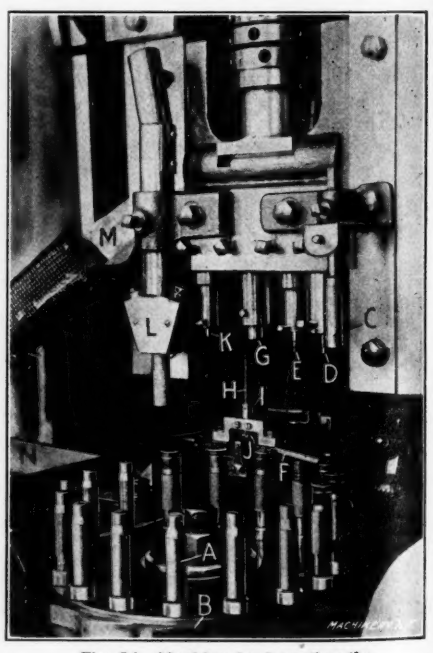

Fig. 54. Machine for Inserting the Primers

The battery pockets are fed automatically to this machine by a hopper-feeding device which is attached to the rear of the machine. The pockets pass from the hopper to a slide where they drop out. A groove is cut in this slide which is equal to the outside diameter of the pocket, thus making it impossible for the battery pockets to be located in this slide except with the flange up. As the battery pockets are located in the slide, they pass down to the feeding device, which consists mainly of two fingers. One finger carries the pocket from the slide to the second finger which carries it out and holds it central with the hole in the head of the shell. These fingers are operated by a lever, which is connected eccentrically to the driving shaft. As the finger carries the pocket out and holds it central over the hole in the shell, the ram descends and a punch held in the bolster *K*, forces the pocket out of the finger into the shell. The pick-up *L* removes the shells from the pins, and transfers them up through the hollow spindle *M*, depositing them in the chute *N*, from which they pass into a box. The condition of the shell after this operation is shown at *E* Fig. 47.

Piercing the Battery Pocket, Priming and Inspecting

The next operation on the cartridge is the piercing of the battery pocket and the inserting of the primer. This is accomplished in the machine shown in Fig. 54. The shells are placed on the pins *A*, sixteen of which are held in the ratchet-dial *B*. As the dial passes around, the punch *C* seats the shell down on the pin. This punch also flattens the head slightly and upsets the pocket in the base wad, as shown at *D* and *F* in Figs. 37 and 47, respectively. The punch *D* pierces the hole in the pocket, while the punch *E* acts as an emergency piercing punch, and also forms the inside of the bat-

tery pocket to the correct diameter. A plate *F* is held over the top of the pins to prevent the piercing punches from lifting the shells, when sizing and piercing the battery pocket. The punch *G* again seats the shells on the pins, before the primer is inserted.

The primers are placed in the brass tube *H*, which is held in the bushing *I*. This tube passes up at the rear of the machine, and is encased by a sheet-steel plate, so that if the primers in the tube should explode, the operators would not be injured. The primers drop through this tube and are removed from it by a finger *J* held to a slide, which carries the primer to a central position over the pocket. This slide is actuated through levers connected to the crankshaft of the press. As the finger carrying the primer advances to a central position over the pocket in the shell, the punch *K* descends and forces the primer out of the finger into the pocket. The dial is then rotated and the pick-up *L* removes the shell from the pin and transfers it to the chute *M* as previously described. This chute is made from wire netting, and leather strips are placed on the side to prevent the shell from being bruised.

The object of having the wire netting is to allow any loose fulminate, which may have been removed from the primer, to drop into the box *N*, which is partially filled with water. If this fulminate were allowed to go into the box in which the shells are placed, an explosion might result, so that it is well to take this precaution. The pierced and primed shell is shown at *F*, Fig. 47. Before the shells can be transferred to the loading department, it is necessary that they should pass through a rigid inspection. This consists in seeing that all primers are located below the top surface of the head of the shell, and also that the paper case is not dented or marked in any way. Any shells which are found to have these defects are scrapped.

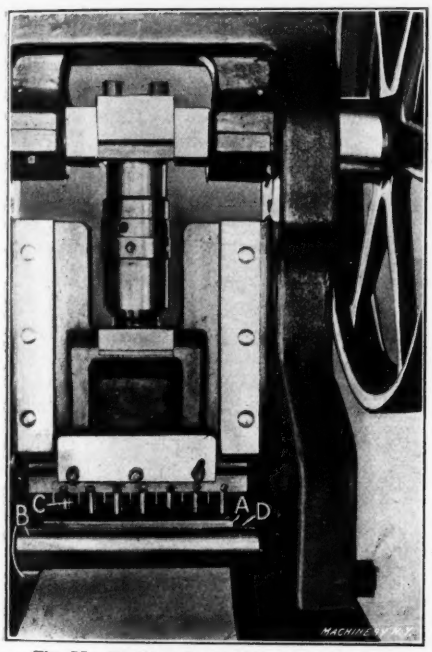

Fig. 55. Machine for Cutting and Greasing the Felt Wads

Cutting and Greasing the Felt Wads

As can be seen at *G* in Fig. 47, three felt wads are used to separate the shot from the powder. These wads are also shown at *L*, *M*, and *N* in Fig. 37, and are used for two reasons: One is to separate the powder from the shot and to give it the required compression; and the other is to prevent the powder from becoming damp. To perform this latter function it is necessary to grease the wads, so as to make them waterproof. This is accomplished in the machine shown in Fig. 55 in which the wads are also cut. The felt for these wads comes in strips about 10 inches wide and is fed into the machine by the rollers *B*.

Fourteen punches *C* are held to the ram of the press for cutting out the wads, and cutting dies registering with these punches are held in the die-block *D*. As the wads are cut out, they pass through the dies into tubes located in the die-block. These tubes have holes drilled through them, and around their periphery, through which grease held in a reservoir in the die-block can pass in to the wads. The grease is kept at the proper temperature by means of steam pipes, which pass into the die-block. The greasing tubes pass through the bolster and down through the bed of the press, so that the wads, as they are cut out and greased, fall into a box under the machine. The three felt wads shown at *L*, *M* and *N* in Fig. 37, are all cut out and greased in a similar manner in this machine.

Loading and Testing

All the component parts of the shot shell, which are illustrated in Fig. 37, have been completed. The operation now to be accomplished is the assembling of these various parts in the paper container or shell, thus making a completed cartridge. The various parts as made are transferred to the shot-shell loading department where the shells are placed in the slide of an automatic loading machine. The shells pass from this slide down a chute from which they are located in holes in a ratchet-dial. As the shells are located in the dial mouth up, they first pass under a container in which is held a sufficient charge of powder.

The container which holds the charge of powder has a slide beneath it which is actuated by an eccentric rod connected to a shaft at the rear of the machine. The function of this eccentric rod is to open and close the container, so that the powder can drop out into the shell. As the shells pass around further, the wads are deposited in them. These wads are held in four brass tubes which hold the various wads in the correct order in which they are to be placed in the shell. The wads are carried from these tubes out to a position central with the shell by slides which are actuated by eccentric rods, as already mentioned. All the wads are fed to the shell in this same manner.

When the last of the felt wads is placed in the shell the shot is inserted. This is held in a container, and is removed from it in the same manner as the powder. As the dial passes around still further the cardboard wad on which the number of grains of powder and the size of the shot are marked, is taken from the last of the four tubes, and punches are used to seat the wads in the shell as they are carried out by the finger and held in a central position.

The last operation on the shell is the turning in of the top edge, or the "crimping operation" as it is called. This crimper consists of a die in which hardened pins are driven. These hardened pins are so formed that they turn over the top of the shell. The crimper is driven by a belt, which runs over two idler pulleys, and drives a pulley which is connected to the spindle holding the crimping die. After the loading and crimping operations the cartridge is in the condition shown diagrammatically at *G*, Fig. 47.

This completes the manufacturing operations, and the cartridges are now ready for the last inspection, which consists in testing them for accuracy. As a shot shell does not contain one bullet, but a collection of small shot, the speed of the shot is not a very essential consideration. However, the charge of shot must be confined to a certain space when fired at a specified distance. The No. 12 gage Imperial shot shell is not allowed to pass the testing inspection unless two-thirds of the charge of shot fills a 30-inch circle, when the cartridge is fired at a distance of 30 yards. As the number of grains of shot in the shell is known, it is an easy matter to determine whether these shells are loaded correctly or not. Shot shells are packed by hand in boxes which contain 25 and 50 cartridges, respectively.

* * *

An engineer has been defined as a man who can do for a dollar what the untrained man could do perhaps for two dollars, and the skill of the machine designer and builder is sometimes displayed to the best advantage on the machines that must be produced at extremely low price. If cost is not limited, a result can be attained by many designers in otherwise satisfactory ways, but the test is price with efficiency. A low-priced machine found in nearly every metal-working plant is the power hack-saw, but the small machine built by a Chicago concern beats them all in point of price. It is almost entirely a foundry product, slides and some bearings being used as cast, yet it has all the functions required of a small machine, and sells for $15. When it is considered that it meets more than the average requirements for accurate cutting-off and has provision for taking up wear, the accomplishment is remarkable.

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MACHINERY

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MAY, 1911

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

HEAVY CRANK PRESSES

One of the interesting and notable developments of modern manufacturing is the general use of heavy crank presses for work which a decade ago it was considered practicable to produce only on a hydraulic press, or in the form of castings. Crank presses capable of exerting five hundred tons' pressure are not uncommon, while several presses of this type are successfully producing work requiring a pressure of two thousand tons—a capacity which ten years ago was considered almost impossible to attain (except in the regular coining press) and almost unnecessary. In this connection it is interesting to note that ten years ago the heaviest crank press built, weighing about 150,000 pounds, could be bought for less than $12,000, while within the last two years crank presses have been built weighing about 280,000 pounds, and selling at about $20,000.

Presses of the great capacities mentioned are necessarily heavy and expensive, and when a mammoth crank press is compared superficially with a hydraulic press of the same capacity, the reason is sought for preferring the crank type. The answer is one that has decided the fate of many other types of machines—namely, greater efficiency.

The crank press is simpler, not so likely to get out of order, and quicker in its operation than a hydraulic press exerting the same pressure. An ordinary, intelligent operator can make minor repairs; all movements and adjustments are positive; there are no valves nor glands to leak, no pipes to freeze nor accumulators to require attention as in the hydraulic type. The crank press can be independently driven by electric motor or by belt from the lineshaft, the same as other machines. The hydraulic press, on the other hand, requires a special high-duty pump, high-pressure pipe lines and an accumulator—all comprising an expensive apparatus requiring the attention of mechanics of some special experience and of a higher degree of intelligence than are usually found in the average "press-room."

In view of the rapidity with which former hydraulic press users are converting their equipments to crank presses, and the ever-increasing substitution of stamped and forged steel parts for many of the heavier castings, it is not chimerical to predict that the crank press will be developed to a size approximating five thousand tons' capacity within the next ten years, and this probable development is one that should interest machinery designers generally, whether directly connected with the press-working of metals or not. The article in another part of this number, treating of the uses, abuses and construction of heavy power presses, written by an engineer of long practical experience in press design, may be considered as preliminary to further articles that will treat of rational power press design.

* * *

METHODS INSTEAD OF MACHINES

The Pratt & Whitney Co. recently established a novel record in furnishing a complete equipment for the manufacture of an army rifle for a foreign government. The contract for the equipment did not mention the machines to be furnished, its main clauses specifying that the Pratt & Whitney Co. was to furnish a detailed method, including the machines and devices required for its efficient use, in order to produce a rifle in a certain number of man-hours.

While there are probably many opportunities of this kind, they are open to only a few manufacturers, because a high order of ability and long experience are necessary before a machine tool builder could furnish such equipment profitably on the basis referred to. Instead of furnishing so many lathes, so many milling machines, so many grinding machines, etc., he must contract to furnish a method and equipment for making, say, a certain number of meat grinders or sewing machines in so many hours, the equipment to be furnished at a stated price. The *method* must be the principal consideration, and only an expert could furnish this. The machinery would, in a sense, become an auxiliary, being adapted to carry out the work in the most efficient manner according to the method laid down. It would, of course, be impracticable for a manufacturer specializing on a certain kind of machinery to accept orders based on this principle, but it is probable that the future will see a development of the idea of furnishing methods on a basis somewhat similar to general contracting. A responsible firm will contract to guarantee a required result for a certain price. It will then proceed to gather the necessary machinery from the manufacturers, and the special machinery it will either have built to order or build in a plant of its own. This development in the machine tool building business may yet be far off; but there are firms who could even now profitably adopt this plan on a small scale, provided their organization included the required mechanical experience and ability.

* * *

DIFFICULTIES IN ACQUIRING FOREIGN TRADE

In a recent editorial, attention was called to some complaints made by foreign customers regarding American methods of handling foreign trade; but American manufacturers are not always to blame, as the following extract from a letter shows:

"It is not unusual for us, and we have no doubt others have the same experience, to receive an inquiry on a postal card, and not infrequently a letter, to which it is impossible to reply, because it is absolutely impossible to decipher the signature. And frequently it is impossible to ascertain the place from which the communication is addressed. The name of a town may possibly be given, but whether it is in Germany, Russia, France or some other country, cannot be determined. The writer evidently knows who and where he is, but nobody else does, and no answer can be sent to the inquiry with any assurance of reaching its destination."

The experience of this manufacturer is not unusual. We have had similar difficulties in this office and have had considerable trouble in locating some small European town from which letters have been received. In Europe, a universal knowledge is assumed of the location of all towns, large and small, but a little thought would show that the American manufacturer is not likely to know, for example, whether the town of Obernburg is located in Germany or Austria; or the town of Lombers in France, Italy or Switzerland.

MACHINE TOOL CATALOGUES

Many machine tool catalogues and pamphlets would be of greater value to the manufacturers whose tools they illustrate if more attention were given to their preparation. Undoubtedly a prospective buyer often gets his first impression of a machine from a catalogue; but in many instances the catalogue contains so little definite information that it is impossible to arrive at any intelligent conclusion regarding the merits of the tool represented. As the superiority of a machine, as a whole, depends largely upon the superiority of its parts, what is needed is more specific information, accompanied by illustrations showing the design and construction of details. By preparing a catalogue in this way good points in the construction could be directly referred to, so that anyone interested might judge for himself as to the merits of the machine generally. This plan has been followed to some extent by manufacturers, but much of the literature of this class that is sent out contains little more, in the way of illustration, than a general view, and the description is largely made up of abstract statements which are general in their character. Catalogue writing should be done by some person having a thorough knowledge of the tools illustrated, and instead of meaningless claims of superiority, such features as the convenience of control, directness of transmission, durability, rigidity, etc., should be made apparent by detailed views and descriptive matter. A sectional view is rarely seen in a catalogue, notwithstanding the fact that such illustrations could be used to show strong features that would be entirely concealed in a photograph. Views of this kind would also illustrate noteworthy points without verbal explanation. A catalogue arranged along the lines suggested would be more effective than the conventional style, and an important adjunct to the sales department.

* * *

MAKING AND USING MACHINE TOOLS

While every maker of machine tools is also a user of them, the average machine tool builder does not place as severe strain upon the machines in his shop as is done in other metal-working plants where the pressure of competition makes it necessary to force the equipment to the utmost. Consequently such users may find defects in the machine tools which the builder using them in a less strenuous manner, would never himself detect. If it were practicable for makers of machine tools to operate plants in which the machines were tried out under the most severe conditions, the improvements required would become apparent much sooner, and many difficulties and complaints might be avoided. As a rule, such a combination of machine tool building and manufacturing, quite common in Europe, does not harmonize with the modern idea of specialization, and would generally be impracticable; but one interesting exception may be cited. The Billings & Spencer Co. of Hartford, Conn., makers of an extensive line of drop forged articles, also make for sale a line of the machines used in the company's own plant, including drop hammers; and their experience demonstrates that a great advantage results from this combination of machine building and manufacturing. The usage to which drop hammers are subjected is severe; but it appears that the machines are subjected to even more severe conditions in the company's own plant than in their customers', partly because the men use less care in handling the machines in the home shop, knowing that if anything breaks down it can easily be repaired right on the spot. In a shop hundreds or thousands of miles away from the maker's plant, greater care must necessarily be exercised in operating machines of this type, on account of the long delay which would result from a breakdown. An excellent test of the machines under actual working conditions in the Hartford works, and a very severe test at that, is thus continually in process; and the firm has an unusual opportunity to note where any improvements should be made.

* * *

When you have once acquired a good reputation, concern yourself more with protecting it than with trading on it.

THE PATENT MICROBE

By J. CROW TAYLOR*

We may have the hook worm or some germ that makes for a lassitude and laziness in this country, but if so, we have something else to offset it—something we might call the "patent microbe." This is a very active microbe too, judging from the records; it is a sort of busy-bee and it is busier in the United States than anywhere else in the world. The *Official Gazette* of the patent office has recently given out some figures that prove this, and also prove that the patent office is one of the government institutions that is a money-maker. One of the important things shown by these statistics is that there was a balance to the credit of the patent office at the beginning of this year of the snug little sum of $6,988,228.

There have been issued in the United States since the establishment of the patent office approximately a round million patents or nearly as many as those issued by all the rest of the world. During 1910 there were 63,293 applications for mechanical patents, 1155 for design patents and 181 for reissues; this is aside from trade-marks, registrations and labels. The number of patents expiring during the year was 22,768, and the number issued during the same period was 35,807; so we are about 13,000 patents to the good for last year. And there were at the time of compiling the statistics, 11,336 awaiting final fees before issuing.

Some idea of the great activity of the inventive genius and the comparatively great number of applications for patents in the United States may be had from the fact that the total in the United States is more than double the next country in importance, which is Germany. The total number of patents granted in the United States from 1871 to 1910 was 869,561; and Germany ranks second with a total of 440,898; Great Britain third with 425,374; then comes France with 248,106, Belgium with 239,500 and Canada with 136,390.

It is impossible to obtain any definite information as to what percentage of the patents issued in the United States have proved of value to the inventors. That some of them have we all know, because the conspicuous examples of success are always advertised; but there is a great multitude of patents that never pays a profit to anybody but the patent office. Sometimes unfortunately these commercial failures stand in the way of other inventions that might be commercially successful, because they cover certain features that are a bar to the planning of other inventions until the time limit expires. Some day the patent laws will probably be amended so as to eliminate what might be termed dead-letter patents, meaning thereby those patents that have not been put into general use—that have proved a failure so to speak. This will clear the road for other inventors to try their hand.

Whatever else we might say of the patent business in the United States, there is one thing certain, and that is that the inventive genius is more active here than anywhere in the world and it is accompanied by a commercial desire for profit that often leads the genius to the patent office with but a meager offering. The patent microbe does not need encouragement nor propagation; it has taken care of itself in this country and about all it really needs is a little more specific attention in the way of direction and supervision. In other words, it needs regulations like some other of our big institutions.

* * *

Pierre Vedrine, an amateur aviator who qualified only last December and formerly was a mechanic in the Gnome Motor Works, broke the world's record on March 31 in a flight from Poitiers to Issy-les-Moulineaux, France. The distance of 335 kilometers (208 miles) was covered at the rate of 94.6 miles per hour, the time of flight being only two hours and twelve minutes. Vedrine used a 50-horsepower Morane machine, which is capable of making 130 kilometers (between 80 and 81 miles) per hour. A light breeze favored the flight. The claim is made that the same speed on the best highway would have required a 150-horsepower motor.

*Address: Masonic Building, Louisville, Ky.

SHOP TRUCKS IN THE WASHBURN SHOPS

By H. P. FAIRFIELD*

In many shops too little attention is paid to the tiring of workmen. The workman's particular value to any firm is his ability to skilfully and rapidly perform his assigned work; and while fatigue may or may not alter his skill, it most certainly causes a falling off in the rapidity with which the work is done.

The order of operations as carried forward at the machines in many shops is to assign to the workman a certain number of machine parts to finish. He proceeds to hunt up a shop truck and probably a box to hold the pieces. In the snagging room, he counts out and fills his box with the requisite number of castings, and trucks them to his machine, dumping them upon

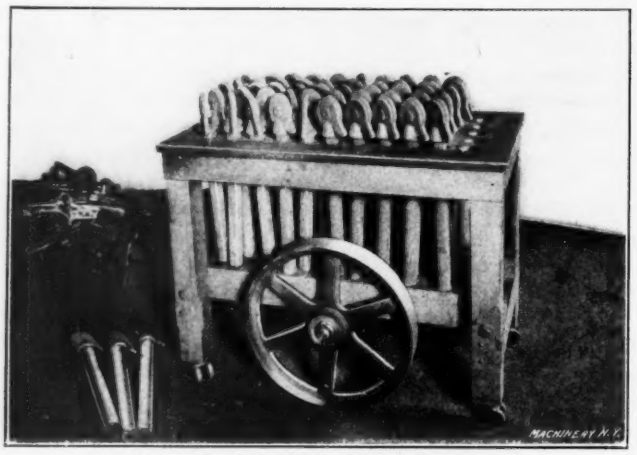


Fig. 1. Truck loaded in the Snagging Room

the floor beside him. From here he must lift the individual pieces to place them in the machine, and when one operation is finished, back they go to the floor. Here they are under foot and of necessity more or less scattered about and covered with chips and dirt. The shop sweeper brushes around and over them—perhaps shifts them about—mixing them up more or less. From this machine, the parts, after being again placed upon the shop truck, are trundled to the machine upon which the next operation is to be performed, and are again dumped upon the floor. This procedure is carried forward until the completion of the parts, when they are placed in the stock room, or, in some cases, stowed away beneath the work benches. To many, this may appear to be a somewhat overdrawn statement of conditions; however, the writer is sure that it still obtains in some shops.

* Address: Worcester Polytechnic Institute, Worcester, Mass.

The accompanying photographs show how this loss of time and effort, and the general unthriftiness of the above-described conditions are avoided in the Washburn Shops of the Worcester Polytechnic Institute. For the benefit of those who do not know, it might be stated that the Institute shops are operated upon a commercial basis and under normal business conditions, about forty workmen being employed in machine tool

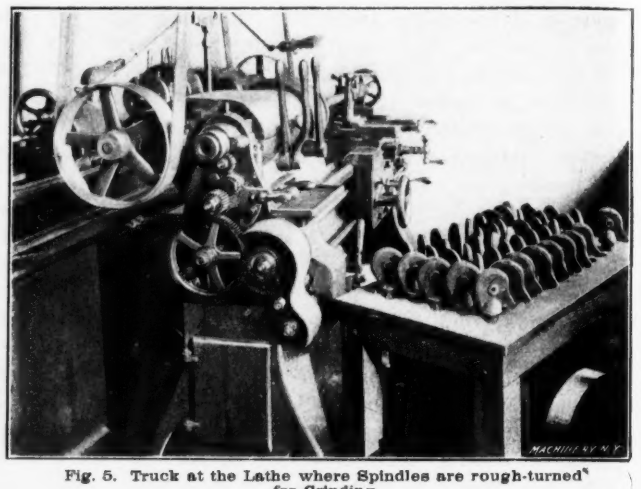


Fig. 5. Truck at the Lathe where Spindles are rough-turned for Grinding

manufacturing. The problems incident to economical handling of work are thus the ones which are to be found in other shops. While the photographs well illustrate the idea, it may be pertinent to state that the parts are, when they are snagged, put into a specially constructed shop truck and remain with it until they go either to the assembling floor or to the stock room. While in a general sense the special trucks are the same, they are built to suit the kind of work which they are supposed to carry. That shown in the photographs is one of several made to carry the spindles of the Worcester drawing stands. Each of these is provided with five rows of holes of eleven holes each, or fifty-five holes in all. Fifty spindles are carried in each truck, which allows a vacant hole in each row. In use at the machine, a spindle is withdrawn from its hole, operated upon in the machine, and then replaced in the previously vacant hole. This shows, when the piece is being machined, two vacant holes in the row from which the piece is taken and one vacant hole between the replaced piece and the next in order. Thus, if the workman's attention is called from his work after replacing a piece, he can never be in doubt as to the row of parts he is selecting from or the piece which should next be taken. In other words, when the work upon the parts has begun at any particular

Fig. 2. Truck at the Centering Machine

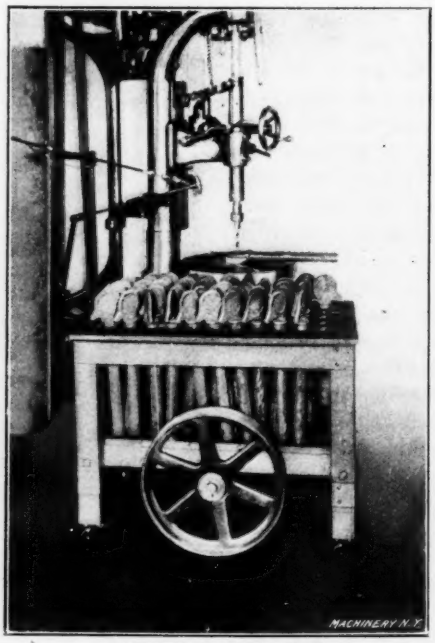


Fig. 3. Truck at the Drill Press

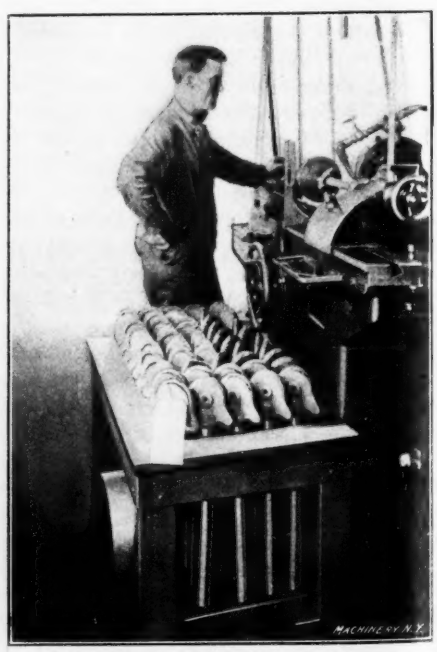
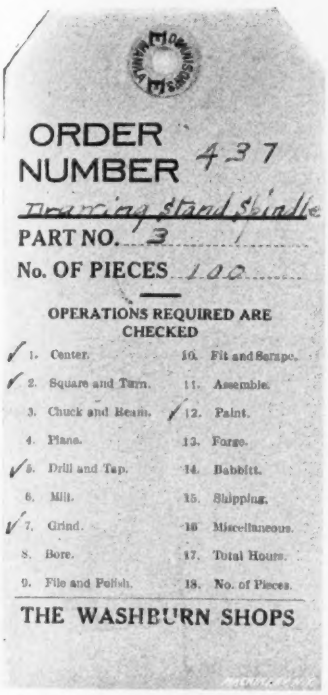


Fig. 4. Truck at the Grinding Machine for the Final Operation

machine, the order of withdrawing and replacing is such as indicates the next piece even if the workman is inattentive.

When the truck is first loaded, an order tag is attached. This is shown in some of the views and remains with the lot until they are finished. Upon this tag is given the order number, part number, number of pieces, and the operations required. The face of this tag is plainly shown in Fig. 6. The foreman, on issuing, checks off the different operations for the pieces, and the tag thus becomes a routing card for the lot from machine to machine.

The trucks are strongly built and provided with castors at each corner. The larger wheels in the center are for transportation purposes and are made of sufficient size to trundle easily on the shop floor. The truck body is hung to these in such a manner as to allow of its being rocked to bring the castors clear of the floor, so that the whole truck may be easily swung or turned at the will of the user. As the trucks must be moved into a convenient position at the various machines, the size of the truck frame is considered and unless the work is to be finished at one machine only, it should seldom be larger than 2 feet by 4 feet; 18 inches by 36 inches is a good size.


ORDER NUMBER 437

Drawing Stand Spindle

PART NO. 3

No. OF PIECES 100

OPERATIONS REQUIRED ARE CHECKED

✓	1. Center.	10.	Fit and Scrape.
✓	2. Square and Turn.	11.	Assemble.
	3. Chuck and Ream.	✓	12. Paint.
	4. Plane.	13.	Forge.
✓	5. Drill and Tap.	14.	Babbitt.
	6. Mill.	15.	Shipping.
✓	7. Grind.	16	Miscellaneous.
	8. Bore.	17.	Total Hours.
	9. File and Polish.	18.	No. of Pieces.

THE WASHBURN SHOPS

Fig. 6. Tag that accompanies the Order as it progresses through the Shop

Fig. 1 shows the truck after being loaded at the snagging room; Fig. 2, at the centering machine; Fig. 3, at the drilling machine; Fig. 5, at the roughing-out lathe; and Fig. 4, at the grinding machine, which is the final machining operation, the parts going from there to the assembling floor where they are removed from the truck.

In connection with the course in shop engineering at the Institute, a study of costs for work done with and without the use of these special trucks showed that they effected a considerable saving of time. In some cases this was of course more marked than in others, but in all cases investigated, the time-saving effect was very noticeable. The principal savings of time are from four sources: (a) The workman's energy is not sapped by unnecessary efforts; (b) in taking up and replacing the pieces, his route to and from the work table of the machine is a shorter distance than from the floor; (c) no time is lost searching for and reloading the usual shop truck to convey the parts to the next machine; (d) the arrangement of holes is such that no time need be lost in selecting the next piece to be operated upon. The foregoing saving of time may properly be considered saving time at the machines. Several other minor time savings may be mentioned as follows: An order is issued for 100 parts and this order goes to the snagging room for this number of castings. With each truck, as in this case, holding 50 pieces, the snagger simply fills two truck and trundles them to the operator, and a glance shows him whether the count is right. Also the foreman can tell at any time whether or not the workman has the number ordered by noting whether it agrees with the order tag. This obviates the annoyance of finding, when the machines are being erected, that some of the parts are short and that a small make-up order must be issued to fill the quota for 100 machines. Small orders run through in this manner are always more expensive, as the time of setting up for any operation must be divided by the small number being made, increasing thereby the piece cost, and of course the cost of the lot. Otherwise, the lot must remain incomplete, with say 97 fully completed machines and 3 partly completed. This renders doubtful and inexact all figures on the cost of the lot.

Where the firm gets its castings from an outside foundry, the trucks offer an excellent means of checking up the number and weight of parts delivered. In this case the castings are sorted into the respective trucks; as each truck holds a specified number they are self-counted. The weight of the empty trucks is known; therefore running them upon the scales easily gives the weights delivered. As before, this gives at a glance the number of each machine part delivered and any shortage in numbers or errors in weights can be corrected at once. The trucks then not only effect a saving of time, but can be made to save the foreman annoyance and loss of temper. This all makes for efficiency, and efficiency makes for a successful business.

* * *

CONVEX FLUTING CUTTERS

Quite frequently, in ordinary toolmaking practice, a regular convex cutter is used for fluting taps. In selecting a half-round (convex) cutter for tap fluting, the formula commonly recommended for determining the proper thickness of cutter is as follows:

$$T = \frac{8\,D}{3\,N}$$

in which T = thickness of cutter in inches,
D = diameter of tap,
N = number of flutes.

It is claimed by some makers of taps that a better proportion of land and flute is obtained by a modification of this formula. For taps up to ½ inch in diameter the formula should thus be:

$$T = \frac{9\,D}{4\,N}$$

and for taps larger than ½ inch in diameter:

$$T = \frac{8\,D}{3.5\,N}$$

For example, if a ¾-inch tap with four flutes is to be fluted with a convex cutter, the thickness of the cutter would be:

$$\frac{8 \times \frac{3}{4}}{3.5 \times 4} = \frac{6}{14} = 0.43, \text{ or } 7/16 \text{ inch, approximately.}$$

* * *

ABSURD SPECIFICATIONS

The maker of a disk grinder was asked to submit estimates on the job of grinding the sides of blanks for small gears used in a magneto. The blanks after grinding were strung on an arbor for cutting the teeth. Of course, the sides were required to be parallel and the specification further required that the blanks be ground to one-half thousandth inch limit in thickness. A production rate of 250 per hour was finally established on test, and the machines were ordered and accepted. In the user's plant a production rate of over 300 blanks per hour was attained, or 20 per cent more than the maker's estimate. The reason was simply that the thickness was not closely limited and the blanks were actually ground to limits of five thousandths inch or more. The original specification was absurd, and the case illustrates the need of more engineering "horse sense" in the purchasing department of large manufacturing plants. The maker was doubtful of the success of his machine under the severe terms imposed and might have declined to furnish it. Had he known the actual conditions there would have been no hesitation whatever in guaranteeing the character and number of pieces produced.

* * *

A slender hook of irregular shape used in the "stumbling" mechanism of the Barber-Colman warp-tying machine is hardened to resist wear. It is subjected to repeated shocks and has given some trouble from breakage. Many kinds of steel and processes of hardening were tried without success until the following combination was hit upon: Steel, five per cent nickel; treatment, heat thirty-five minutes in case to temperature of 750 degrees C. and dump contents of pack into oil bath. The cases are made of 3½-inch pipe cut to 3-inch lengths and closed at the ends. The hooks are packed radially with the hook ends toward the center.

HORSEPOWER OF STEAM ENGINES*

By C. C. CARISS†

In all probability no formula has been printed as frequently as the following horsepower equation:

$$I.H.P. = \frac{PLAN}{33000}$$

in which

$I.H.P.$ = indicated horsepower;
P = mean effective pressure;
L = length of stroke in feet;
A = area of cylinder in square inches;
N = number of working strokes per minute.

In this equation the only term that cannot be obtained directly is P, the mean effective pressure. This is given by the steam expansion equation of Mariotte's law where

$$P_m = P_a \left(\frac{1 + \log_e R}{R} \right)$$

in which

P_m = mean absolute pressure,
P_a = initial absolute pressure,
R = ratio of expansion,
$\log_e R$ = hyperbolic logarithm of ratio of expansion.

From this mean absolute pressure the mean effective pressure may be obtained by subtracting the absolute back pressure P_b, or

$$P = P_m - P_b$$

Now it frequently so happens that a prospective purchaser wishes to know the horsepower of an engine under different conditions of steam pressure, cut-off, back pressure and speed, both condensing and non-condensing; also a comparison might be required between the sizes of high-speed, medium-speed and slow-speed engines which would give the same horsepower. In addition, if a compound- or triple-expansion engine is decided upon, the size required is desired.

The tables given in the Data Sheet enable these questions to be rapidly and accurately answered. The first horizontal line gives the per cent of stroke at which cut-off occurs; the second line, the corresponding ratio of expansion; the third line, the hyperbolic logarithm of the ratio of expansion; and the fourth line the value of $\frac{1 + \log_e R}{R}$ for the various ratios of expansion. This latter term may be designated the *expansion factor*.

From these values the various mean absolute pressures may be derived by simple multiplication. The first vertical line gives the absolute pressures, while the second tabulates the corresponding gage pressures as measured in pounds per square inch above atmospheric pressure by the usual pressure gage.

In using these tables for a simple engine, first find the required pressure in either the first or second vertical lines, and then run the finger along that pressure line until it is directly below the required point of cut-off, at this point reading off the mean absolute pressure. From this pressure subtract the absolute back pressure, which may usually be taken as 4 pounds per square inch condensing, and 18 pounds per square inch non-condensing, this resulting value being the mean effective pressure which can be inserted in the horsepower formula. The horsepower formula may be very rapidly solved by using Hudson's horsepower computing scale, which is a special slide-rule for this purpose, sold in America by Keuffel & Esser, New York.

The method of procedure is much the same in the case of a compound-, triple- or quadruple-expansion engine. In the first place, divide the area of the low pressure cylinder by the area of the high pressure cylinder, thereby obtaining the cylinder ratio. Dividing the per cent cut-off in the high pressure cylinder by this previously determined cylinder ratio gives the equivalent per cent cut-off in the low pressure cylinder, considering all the expansion to have occurred there. Finding the mean effective pressure as before, the indicated horsepower may be determined in the same way, basing the calculation on the low pressure cylinder area.

It should be noted that in a multiple-expansion engine the areas of the intermediate cylinders have no serious effect on the power of the engine, but simply act as a series of graduated steps through which the steam passes from a high to a lower temperature. Their principal purpose is to avoid the condensation which would occur if the steam passed directly from a hot high pressure cylinder to a comparatively cold low pressure cylinder, the temperature ranges being less, the greater the number of stages.

For ordinary purposes Tables I to III will be found sufficient, but it frequently happens that intermediate values are required. These may be obtained from the curve shown in Table IV. This curve was derived from the previously determined equation

$$P_m = P_a \left(\frac{1 + \log_e R}{R} \right)$$

in the following manner:

As

$$x = \frac{P_m}{P_a} \times 100$$

then

$$\frac{P_m}{P_a} = \frac{x}{100}$$

Also

$$y = \frac{1}{R} \times 100$$

therefore

$$R = \frac{100}{y}$$

Hence

$$\frac{P_m}{P_a} = \frac{1 + \log_e R}{R}$$

and

$$\frac{x}{100} = \frac{1 + \log_e \frac{100}{y}}{\frac{100}{y}}$$

Consequently

$$x = y\,(1 + \log_e 100 + \log_e y^{-1})$$
$$= y\,(1 + 4.605 - \log_e y) = y\,(5.605 - \log_e y)$$

This gives a means of laying out the curve, both the ordinates and abscissas being in per cent.

To use the curve, find the per cent cut-off and follow the corresponding horizontal line until it it intersects the curve, noting the vertical line at that point. This gives the per cent of the initial absolute pressure. Multiply this by the initial absolute pressure, thereby obtaining the mean absolute pressure from which the absolute back pressure is to be subtracted, proceeding as before to obtain the horsepower.

Simple engines are usually rated at 25 per cent cut-off; compound single valve engines at 30 per cent; and Corliss, or other engines giving a diagram closely approaching the ideal may be safely rated up to 35 per cent cut-off. A safe rule for generator rating, is to allow 60 kilowatts for every 100 horsepower calculated at these cut-offs.

The actual indicated horsepower will be less than the calculated by an amount depending on the construction and type of engine. The actual ratio may be found from cards taken from engines of a similar type. The brake horsepower or available useful effort, is found by actual measurements with some form of transmission or absorption dynamometer, or else by deducting the power shown on a diagram taken at no load from the power shown on the diagram taken at any other load. The usual limits of the brake horsepower are from 75 to 90 per cent of the indicated horsepower at full load.

* * *

The Concrete Institute of Great Britain has decided to encourage the contribution of useful papers by awarding a medal annually for the best paper on concrete and its uses, and materials employed in its manufacture.

* With Data Sheet Supplement.
† Designing Engineer, E. Leonard & Sons, London, Canada.

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MEAN ABSOLUTE PRESSURES—I

Mean Effective Pressures Obtained by Subtracting the Back Pressure from the Mean Absolute Pressure:
18 Pounds Non-Condensing, 4 Pounds Condensing (22 Inches Vacuum).

Percent Cut-Off		6	9	12	15	20	25	27.5	30	35	40	50	60	70	85
Expansion Ratio = R		16.67	11.10	8.33	6.67	5.00	4.00	3.64	3.33	2.86	2.50	2.00	1.67	1.43	1.18
Log_e R		2.813	2.408	2.120	1.897	1.609	1.386	1.291	1.204	1.050	0.916	0.693	0.511	0.357	0.163
$(1+log_e R)/R$		0.229	0.307	0.374	0.435	0.522	0.597	0.630	0.661	0.718	0.767	0.847	0.907	0.950	0.989
Pressures															
Absolute	Gage														
8		1.83	2.45	3.00	3.48	4.17	4.77	5.04	5.29	5.74	6.13	6.77	7.25	7.60	7.91
12		2.76	3.68	4.49	5.21	6.26	7.16	7.56	7.93	8.61	9.20	10.16	10.88	11.40	11.86
16	1.3	3.66	4.91	5.99	6.95	8.35	9.55	10.08	10.58	11.48	12.26	13.55	14.50	15.20	15.82
20	5.3	4.58	6.13	7.49	8.69	10.44	11.93	12.60	13.22	14.35	15.33	16.93	18.13	18.99	19.77
24	9.3	5.49	7.36	8.99	10.43	12.52	14.32	15.12	15.87	17.22	18.40	20.32	21.76	22.79	23.72
28	13.3	6.41	8.59	10.48	12.16	14.61	16.70	17.64	18.51	20.09	21.46	23.70	25.38	26.59	27.68
32	17.3	7.32	9.81	11.98	13.90	16.70	19.09	20.16	21.16	22.96	24.53	27.09	29.01	30.39	31.63
36	21.3	8.24	11.04	13.48	15.64	18.78	21.48	22.68	23.80	25.83	27.59	30.48	32.63	34.19	35.59
40	25.3	9.15	12.27	14.98	17.38	20.87	23.86	24.20	26.45	28.70	30.66	33.86	36.24	37.99	39.54
44	29.3	10.07	13.49	16.47	19.12	22.96	26.25	27.72	29.09	31.57	33.73	37.25	39.89	41.79	43.49
48	33.3	10.98	14.72	17.97	20.86	25.05	28.64	30.24	31.74	34.44	36.79	40.64	43.51	45.59	47.45
52	37.3	11.90	15.95	19.47	22.59	27.13	31.02	32.76	34.38	37.31	39.86	44.02	47.14	49.38	51.40
56	41.3	12.81	17.18	20.97	24.33	29.22	33.41	35.28	37.03	40.18	42.92	47.41	50.76	53.18	55.36
60	45.3	13.73	18.40	22.46	26.07	31.31	35.80	37.80	39.67	43.05	45.99	50.80	54.39	56.98	59.31
64	49.3	14.64	19.63	23.96	27.81	33.40	38.18	40.32	42.32	45.92	49.06	54.18	58.02	60.78	63.26

Contributed by C. C. Cariss

No. 142, Data Sheet, MACHINERY, May, 1911

MEAN ABSOLUTE PRESSURES—II

Mean Effective Pressures Obtained by Subtracting the Back Pressure from the Mean Absolute Pressure:
18 Pounds Non-Condensing, 4 Pounds Condensing (22 Inches Vacuum).

Percent Cut-Off		6	9	12	15	20	25	27.5	30	35	40	50	60	70	85
Expansion Ratio = R		16.67	11.10	8.33	6.67	5.00	4.00	3.64	3.33	2.86	2.50	2.00	1.67	1.43	1.18
Log_e R		2.813	2.408	2.120	1.897	1.609	1.386	1.291	1.204	1.050	0.916	0.693	0.511	0.357	0.163
$(1+log_e R)/R$		0.229	0.307	0.374	0.435	0.522	0.597	0.630	0.661	0.718	0.767	0.847	0.907	0.950	0.989
Pressures															
Absolute	Gage														
68	53.3	15.56	20.86	25.46	29.55	35.48	40.57	42.84	44.96	48.79	52.12	57.57	61.64	64.58	67.22
72	57.3	16.47	22.08	26.96	31.28	37.57	42.96	45.36	47.61	51.66	55.19	60.96	65.27	68.38	71.17
76	61.3	17.39	23.31	28.45	33.02	39.66	45.34	47.88	50.25	54.53	58.25	64.34	68.89	72.18	75.13
80	65.3	18.30	24.54	29.95	34.76	41.74	47.73	50.40	52.90	57.40	61.32	67.73	72.52	75.98	79.08
84	69.3	19.22	25.76	31.45	36.50	43.83	50.11	52.92	55.54	60.27	64.39	71.11	76.15	79.77	83.03
88	73.3	20.13	26.99	32.95	38.24	45.92	52.50	55.40	58.19	63.14	67.45	74.50	79.77	83.57	86.99
92	77.3	21.05	28.22	34.44	39.97	48.01	54.89	57.96	60.83	66.01	70.52	77.89	83.40	87.37	90.94
96	81.3	21.96	29.44	35.94	41.71	50.09	57.27	60.48	63.48	68.88	73.58	81.27	87.02	91.17	94.90
100	85.3	22.88	30.67	37.44	43.45	52.18	59.66	63.00	66.12	71.75	76.65	84.66	90.65	94.97	98.85
104	89.3	23.80	31.90	38.94	45.19	54.27	62.05	65.52	68.76	74.62	79.72	88.05	94.28	98.77	102.8
108	93.3	24.71	33.12	40.44	46.93	56.35	64.43	68.04	71.41	77.49	82.78	91.43	97.90	102.6	106.8
112	97.3	25.63	34.35	41.93	48.66	58.44	66.82	70.56	74.05	80.36	85.85	94.82	101.5	106.4	110.7
115	100.3	26.31	35.27	43.06	49.97	60.01	68.61	72.45	76.04	82.51	88.15	97.36	104.2	109.2	113.7
120	105.3	27.56	36.80	44.93	52.12	62.61	71.59	75.60	79.34	86.10	91.98	101.6	108.8	114.0	118.6
125	110.3	28.60	38.34	46.80	54.31	65.23	74.58	78.75	82.65	89.69	95.81	105.8	113.3	118.7	123.6

Contributed by C. C. Cariss

No. 42, Data Sheet, MACHINERY, May, 1911

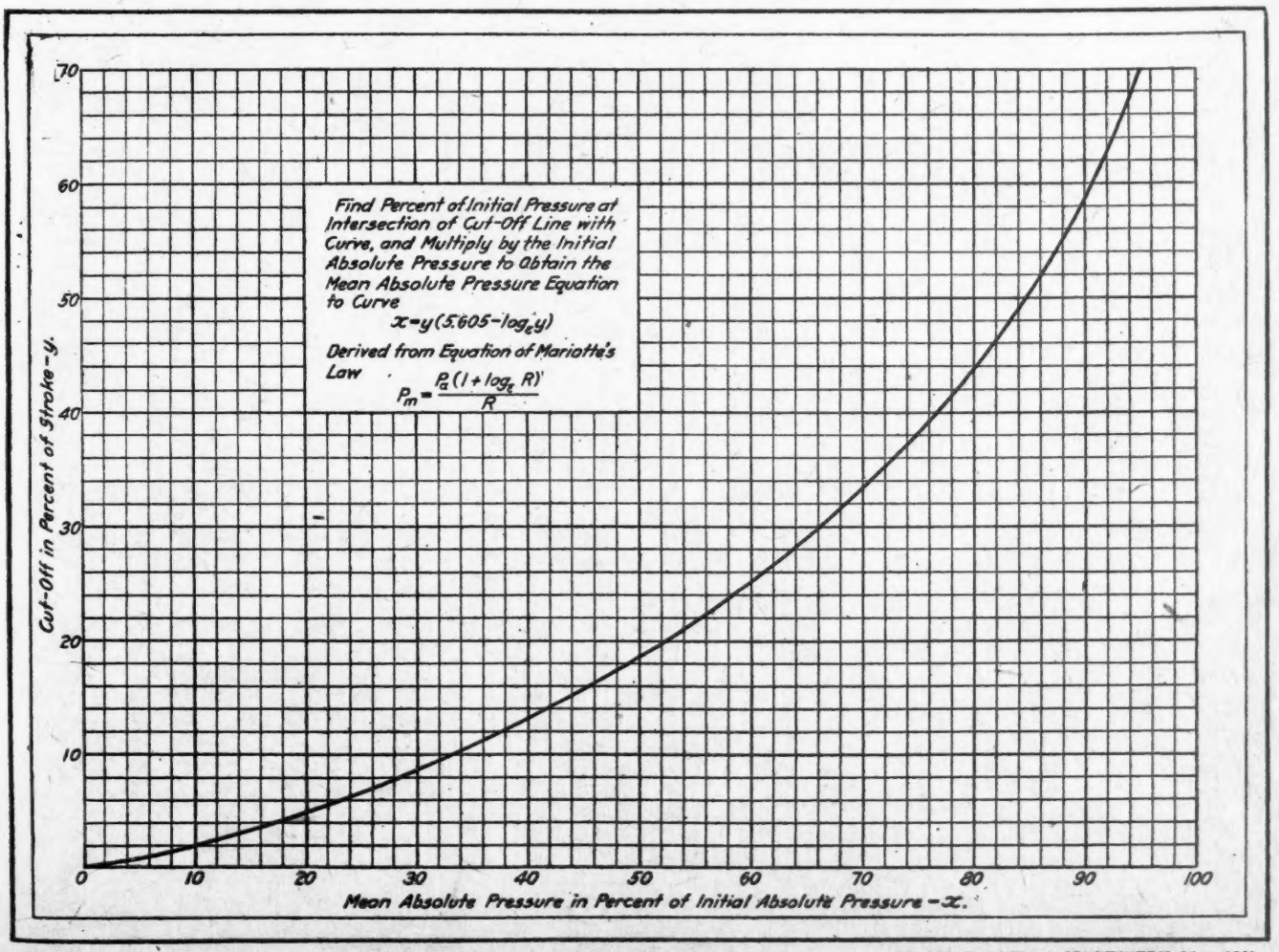
MEAN ABSOLUTE PRESSURES—III

Mean Effective Pressures Obtained by Subtracting the Back Pressure from the Mean Absolute Pressure:
18 Pounds Non-Condensing, 4 Pounds Condensing (22 Inches Vacuum).

Percent Cut-Off		6	9	12	15	20	25	27.5	30	35	40	50	60	70	85
Expansion Ratio = R		16.67	11.10	8.33	6.67	5.00	4.00	3.64	3.33	2.86	2.50	2.00	1.67	1.43	1.18
$Log_e R$		2.813	2.408	2.120	1.897	1.609	1.386	1.291	1.204	1.050	0.916	0.693	0.511	0.357	0.163
$(1+log_e R)/R$		0.229	0.307	0.374	0.435	0.522	0.597	0.630	0.661	0.718	0.767	0.847	0.907	0.950	0.989
Pressures															
Absolute	Gage														
130	115.3	29.74	39.97	48.67	56.49	67.83	77.56	81.90	85.96	93.28	99.65	110.1	117.8	123.5	128.5
135	120.3	30.89	41.40	50.54	58.66	70.44	80.54	85.05	89.26	96.86	103.5	114.3	122.4	128.2	133.4
140	125.3	32.03	42.94	52.42	60.83	73.05	83.52	88.20	92.57	100.5	107.3	118.5	126.9	133.0	138.4
145	130.3	33.18	44.47	54.29	63.00	75.66	86.50	91.35	95.87	104.0	111.1	122.8	131.4	137.7	143.3
150	135.3	34.32	46.01	56.16	65.18	78.27	89.49	94.50	99.18	107.6	115.0	127.0	136.0	142.5	148.3
155	140.3	35.46	47.54	58.03	67.35	80.88	92.47	97.65	102.5	111.2	118.8	131.2	140.5	147.2	153.2
160	145.3	36.61	49.07	59.90	69.52	83.49	95.46	100.8	105.8	114.8	122.6	135.5	145.0	152.0	158.2
165	150.3	37.75	50.61	61.78	71.69	86.10	98.44	104.0	109.1	118.4	126.5	139.7	149.6	156.7	163.1
170	155.3	38.90	52.14	63.65	73.87	88.71	101.4	107.1	112.4	122.0	130.3	143.9	154.1	161.4	168.0
180	165.3	41.18	55.21	67.39	78.21	93.92	107.4	113.4	119.0	129.2	138.0	152.4	163.2	170.9	177.9
190	175.3	43.47	58.27	71.14	82.56	99.14	113.4	119.7	125.6	136.3	145.6	160.9	172.2	180.4	187.8
200	185.3	45.76	61.34	74.88	86.90	104.4	119.3	126.0	132.2	143.5	153.3	169.3	181.3	189.9	197.7
215	200.3	49.19	65.94	80.50	93.42	112.2	128.3	135.5	142.2	154.3	164.8	182.0	194.9	204.2	212.5
230	215.3	52.62	70.54	86.11	99.95	120.0	137.2	144.9	152.1	165.0	176.3	194.7	208.5	218.4	227.4
245	230.3	56.06	75.14	91.73	106.5	127.8	146.2	154.4	162.0	175.8	187.8	207.4	222.1	232.7	242.2

Contributed by C. C. Carlss

MEAN ABSOLUTE PRESSURES—IV


Find Percent of Initial Pressure at Intersection of Cut-Off Line with Curve, and Multiply by the Initial Absolute Pressure to Obtain the Mean Absolute Pressure Equation to Curve
$x = y(5.605 - log_e y)$
Derived from Equation of Mariotte's Law
$P_m = \frac{P_a(1 + log_e R)}{R}$
Cut-Off in Percent of Stroke - y.
Mean Absolute Pressure in Percent of Initial Absolute Pressure - x.
0
10
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60
70
80
90
100

Contributed by C. C. Carlss

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THE "H" ENGINE

By R. W. CROWLY*

In the search for designs that will give motors a high ratio of power to weight and space, some exceedingly ingenious ideas have been presented from time to time; but only when the imperative needs of aviation forced the demand did engineers seek to depart from conventional lines. Since then such engines as the Gnome, R.E.P. and N.E.C. have proved that they have as great reliability as the standard automobile engine, notwithstanding the fact that they are so strikingly different. The successes of these engines have shown that it is foolish to deride any new motor of original design; therefore the advent of the H engine is not so startling, nor can its peculiar merits be doubted.

In this design there are four cylinders arranged vertically in a square pattern, the two lower ones opposed to the two upper, as illustrated by Figs. 1 and 2. Each pair of opposed pistons is rigidly connected by a steel rod between which—firmly bolted to both—is a hollow turned crosspiece. The crankshaft is carried in two bearings, one on each side of the central case which corresponds to the ordinary crank-chamber, and the single crankpin is bushed in a rectangular block that slides on the crosspiece. Though really so simple in design, the arrangement is not easily understood by a mere description, but the illustrations show the important features.

With the ordinary cycle of operations taking place in the cylinders, both the lower and upper pistons obtain a straight-line movement with their rods or mandrels. As the crosspiece is carried up and down by this motion the sliding block works from side to side and carries the crankpin round its circle. This motion is not novel; indeed it is an application of the old Scotch yoke motion still to be found on some

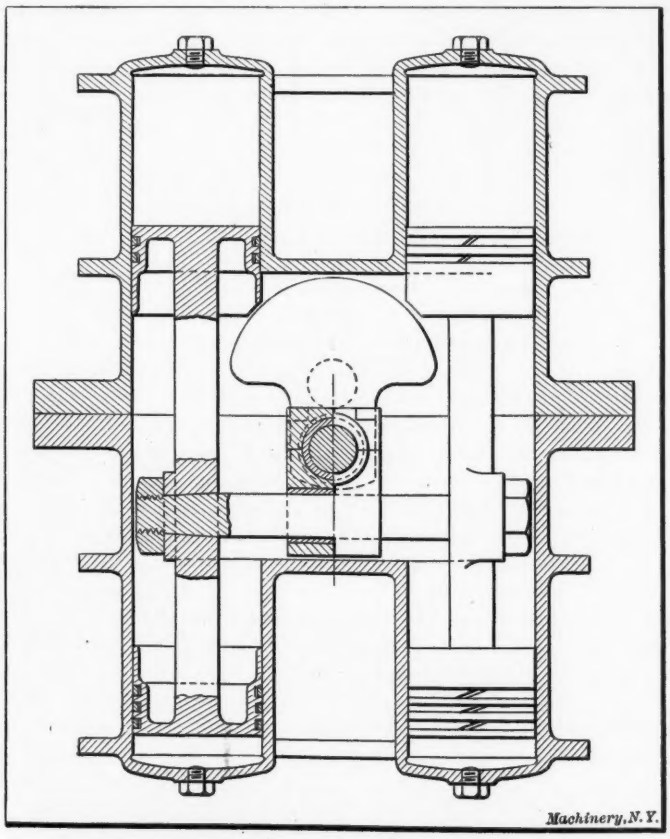

Fig. 1. Cross-sectional View of the H Engine showing Piston and Crank Arrangement

pumps. It is obvious that there must be a twisting action of the sliding block and this might be held to condemn the design. This argument has been advanced, but it is unimportant, for the block is designed to take this stress and therefore works as satisfactorily as any other part of the engine.

In so far as the valves and carbureter are concerned, they are of the ordinary poppet type found on the usual four-cycle motor. Both the water circulation and ignition are also normal, the only variation being in the water jackets, which are of copper, in order to reduce the weight. Lubrication however, is carried out in a special manner; the oil is led first to the walls of the upper cylinders and thence drips from the pistons to the crosspiece, sliding block and crank throw; dropping from there, the oil finds its way inside the lower pistons, which are drilled to permit the lubrication to reach the walls of the lower cylinders. A counterbalance weight is fitted to the crankshaft. A flywheel is also used, but this, however, would be unnecessary in a double unit having eight cylinders.

One of the most important advantages of this design is its simplicity. There are only three main moving parts and four bearings, instead of about a dozen of each as in the ordinary four-cylinder motor. From a manufacturing point of view the

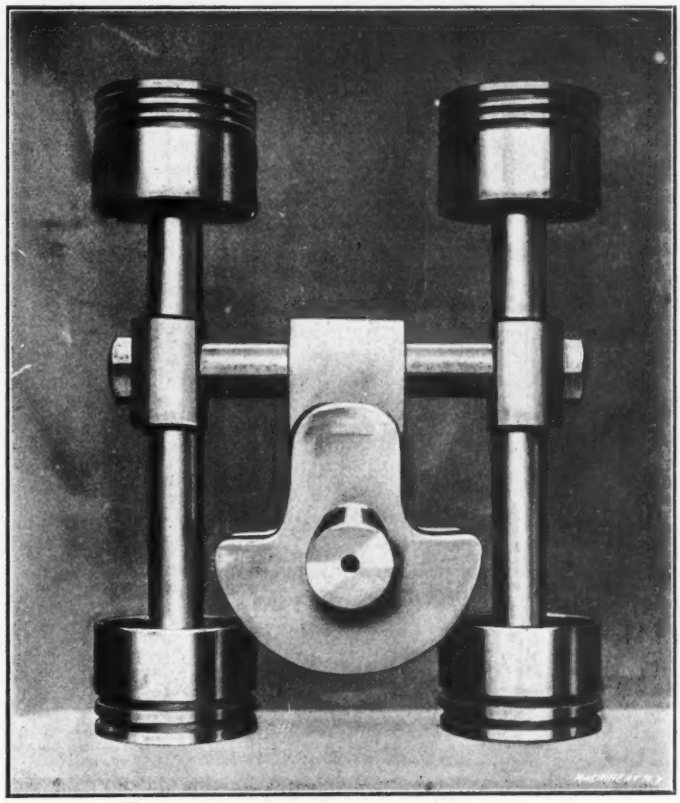

Fig. 2. Pistons, Rods, Crosspiece, Sliding-block and Crankshaft of the H Engine

saving in material and labor is a strong feature, while to the private user these same factors are of some moment, as that means a lower purchasing price.

From four cylinders, having a bore of three inches and a stroke of three inches, fully 20 horsepower is developed. As the outside dimensions are 17½ inches by 14 inches by 7½ inches and the weight only 100 pounds, inclusive of piping, carbureter, etc., the design effects a considerable reduction in two features which are of special account, and this without any of the special weight-cutting practiced by the manufacturers of aviation engines.

Publication has been made before the inventors have had time to submit the engine to exhaustive tests, but in some early trials the motor was run up to 1800 revolutions per minute, at which speed it was quiet and steady. As only one engine has yet been built, it is probable that greater improvement will be made in the matter of space and weight before the motor is placed on the market.

* * *

The importance of the manufacturing plant emergency hospital where minor accidents are treated and first relief given for serious injuries is realized from the impressive figures of the Yale & Towne Mfg. Co.'s plant. Mr. Henry R. Towne recently stated that 14,000 cases were treated during the past year at their Stamford, Conn., plant, where about 3000 persons are employed. Although the service included medical treatment for simple ailments, and a trained nurse is kept in constant attendance during the day, the cost of the hospital was only $1500 for the year. There is no doubt that a big saving of time of employes was effected through having wounds promptly and aseptically treated, thus avoiding infection.

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THE PROPERTIES OF VANADIUM STEEL

By WILLIAM E. SNOW*

Although vanadium has been used to a considerable extent for the past two or three years as an alloy for steel, one frequently hears the question asked: "What is vanadium, and how do vanadium steels differ from other steels?" Vanadium is an element, the existence of which was first recognized by a Mexican, Del Rio, about the year 1800. A number of years later it was discovered that the remarkable qualities of Swedish iron were due to the presence of a small amount of vanadium in the native ore. It is only quite recently, however, that vanadium has been found in sufficient quantity for commercial use.

Pure vanadium is silvery white in appearance, and of very high melting point. In the pure state it has little or no practical application; for use as an alloy it comes in the form of ferro-vanadium, which usually contains from 30 to 40 per cent of vanadium. Vanadium is such a powerful alloy that it only needs to be used in exceedingly homeopathic doses to produce marked results. The use of as small an amount as 0.05 per cent of vanadium produces a strong scavenging action that indirectly toughens the steel to a most noticeable extent, by removing the oxides, nitrides, etc. The use of a larger amount—0.18 per cent, or more—causes a portion of the vanadium to combine with the ferrite or free carbonless iron in the steel, thereby directly toughening it.

Vanadium is very volatile in its action, and considerable difficulty is experienced in getting it to mix thoroughly and evenly with the steel. When put into crucible steels it has a particularly aggravating tendency to go to the bottom of the pot in a lump, where it is frequently found after pouring. The higher the percentage of the vanadium, the greater the difficulty experienced in getting it to mix properly with the steel. It is practically impossible to put over 1.25 per cent of vanadium into steel and keep it there, while most vanadium steels do not contain more than 0.25 to 0.30 per cent of vanadium.

In order to more fully understand its specific action, consider briefly what takes place when vanadium is put into steel. Steel consists of iron, with more or less carbon as the case may be, sulphur, phosphorus, manganese, silicon, and, frequently, chromium and nickel. The carbon contained is combined chemically with a molecular portion of the iron. A molecule of this chemical compound alloys itself with twenty-one atoms of carbonless iron and the resultant alloy is distributed in spots, or patches, through the carbonless iron. This alloy is known technically as pearlite, and the free carbonless iron as ferrite. Part of the manganese unites chemically with the sulphur in the steel, forming striæ, or globules throughout the mass. The phosphorus and the silicon, also the larger part of the nickel—if used—are dissolved in the ferrite in what is known as "solid solution." The chromium is found as a constituent of the pearlite. When vanadium in a sufficient amount is used, it goes into solid solution, partly in the ferrite, which it toughens, and partly in the carbide portion of the pearlite, which it strengthens.

Vanadium is also beneficial to steel in still another way, its use securing better results from the process of annealing, as will be seen from the folowing: When heat is applied to a bar of steel, as in annealing, it becomes sensibly hotter with each degree of heat applied, up to a certain point, known as the point of calescence. When the steel reaches this point, further application of heat does not increase the sensible temperature, but instead, a change takes place in the steel itself; the pearlite becomes broken up, its carbides going into solid solution in the ferrite. When this change is completed, the sensible temperature of the steel again rises. In cooling, the reverse takes place; to a certain point, known as the "point of recalescence," the steel cools regularly, then it apparently ceases to cool, and a change takes place in the steel itself. The dissolved carbides are thrown out of solution, and alloy themselves with the ferrite to re-form pearlite. When this change is completed, sensible cooling again proceeds.

Since the object of annealing is to break up the carbide areas and distribute them in small colonies, the steel is heated above the calescence point, the temperature being maintained long enough to thoroughly decompose the pearlite—as well as to remove any mechanical strains that may have been locked up in the mass by previous manipulation under hammer and rolls. It is then cooled slowly through the recalescence point, care being taken to prevent chilling.

As a vanadium ferrite does not permit of the ready passage through it of the carbides re-precipitated at the recalescence point, the distribution of the carbides in a vanadium steel is remarkably even. This greatly increases the toughness and tenacity of the steel, in addition to the greater toughness already obtained with the background of vanadium ferrite (the portion of the vanadium that has gone into solid solution with the free carbonless iron).

The peculiar properties of vanadium steel are best shown by the following comparative table of the physical properties of vanadium and other crucible steels:

Condition of Steel—Natural, as rolled	Tensile Strength, Pounds per Square Inch	Elastic Limit, Pounds per Square Inch
Carbon Steel	82,300	56,000
Chrome-nickel Steel	102,100	69,230
Chrome-nickel-vanadium Steel	118,100	87,500
Chrome-vanadium Steel	153,220	98,560
Condition of Steel—Annealed		
Carbon Steel	61,100	43,200
Chrome-nickel Steel	81,200	56,700
Chrome-nickel-vanadium Steel	96,350	69,300
Chrome-vanadium Steel	112,000	76,160
Condition of Steel—Oil tempered at 1500 deg. F., drawn to 600 deg. F.		
Carbon Steel	126,300	101,100
Chrome-nickel Steel	150,300	134,500
Chrome-nickel-vanadium Steel	163,700	152,300
Chrome-vanadium Steel	233,090	210,500

From the above table it is seen that the two most marked characteristics of vanadium steel are its high tensile strength (breaking point), and its high elastic limit (stretching point). Another equally important characteristic is its great resistance to shocks; vanadium steel is essentially a non-fatigue metal, and therefore does not become crystallized and break under repeated shocks like other steels. Tests of the various spring steels show that when subjected to successive shocks for a considerable length of time, a crucible carbon steel spring was broken by 125,000 alternations of the testing machine, while a chrome-vanadium steel spring withstood 5,000,000 alternations, remaining unbroken.

Another characteristic of vanadium steel is its great ductility. Highly tempered vanadium steel springs may be bent sharply, in the cold state, to an angle of 90 degrees or more, and even straightened again, cold, without sign of fracture; vanadium steel shafts and axles may be twisted right around, several complete turns, in the cold state, without fracture. This property, combined with its great tensile strength, makes vanadium steel highly desirable for this class of work, as well as for gears which are subjected to heavy strains or shocks upon the teeth.

In the matter of heat-treatment, vanadium steels will stand a wider variation of temperature without detrimental effect than other steels. One particular characteristic of vanadium steel is the evenness with which it hardens. Vanadium steels forge readily, and, in the annealed state, are no harder to machine than an ordinary steel containing the same percentage of carbon. In this respect they differ greatly from other steels of high tensile strength, in which the presence of a considerable amount of nickel renders machining extremely difficult.

The usefulness of vanadium as an alloy is not confined to steel alone; it is equally beneficial to other metals. Cast iron, brass and copper are much improved by the addition of a small percentage of vanadium, their strength and endurance being greatly increased. Castings from these metals show a finer grain and greater freedom from porousness through the use of vanadium. Aluminum, a particularly difficult metal to machine, is greatly benefited in this respect by the addition of vanadium, which not only renders it easier to work, but also insures its ready flow in the mold, producing sharp, even castings from difficult shapes.

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TEMPERING APPARATUS

By JOSEPH R. WEANER*

In general practice it is usually necessary to draw the temper of tools used for manufacturing purposes, but this should be done in one heat, that is, the work should be removed from the bath while it still retains sufficient heat to draw the temper. This method of tempering, however, is sometimes impossible owing to various conditions, so that it is necessary to harden and temper the work in two heats.

The accompanying illustration shows an apparatus installed in a large manufacturing concern, which enables the temper to be drawn at a lower cost, where much of it is to be done and where it is necessary to draw the temper after the work is hardened. This device also produces better work than is usually the case.

Fig. 1 shows the arrangement, in which *A* is a group of three small Bunsen burners with separate stop-cocks *B*, and *C* is an ordinary galvanized-iron pail with a long handle *D* used in place of the ordinary handle. This handle hangs on the bracket *E* which is attached to the wall. Riveted into the bottom of the hook of this bracket *E* is a link of a chain

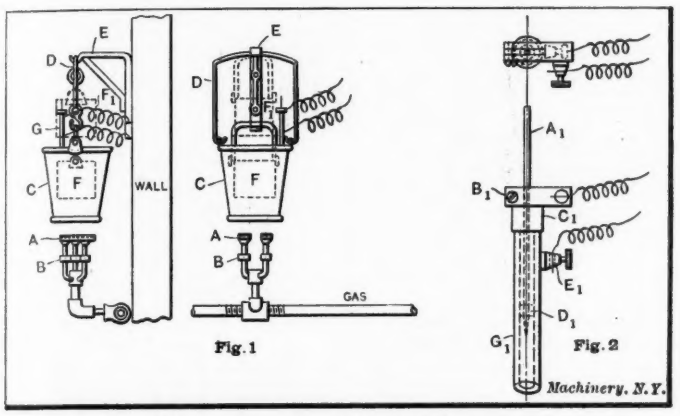


Fig. 1. Tempering Device with an Automatic Alarm. Fig. 2. Details of the Alarm for the Tempering Device

which supports the perforated pail *F* held in the pail *C*, clear of its bottom. The inner pail *F* may also be hooked directly to the bracket as shown at F_1 by the dotted lines, thus raising it out of the pail *C*.

This device should be located close to the hardening furnace, and the quenching bath should also be near, so that the operator may without moving from his place, draw the pieces from the furnace, quench them in water or other solutions, and before they are entirely cold, drop them into the inner pail *F*. The outer pail *C* should be filled to within from one-and one-half to two inches of the top with lard oil or tallow, and heated by the burners to a temperature of 200 degrees F.

When all the pieces to be hardened are in the pail *F* or when it is full, the burners *A* are turned up, thus allowing the oil and all of the pieces therein to slowly heat to about 400 to 600 degrees F. according to the kind of steel and the service required. When the desired temperature is reached the burners are turned out. After the heat has gone down to about the boiling point of water, the pail *F* and its contents should be raised to the position F_1, and the hot oil allowed to drain off. To accurately gage the temperature required, a so-called "chemical" thermometer may be used. These are simply glass tubes with the mercury bulb at one end, and the graduations etched in the tube, having no case. When all the work is in the small pail *F* this thermometer should be placed with its bulb in or on top of the work.

In my own use of this tempering device, as the tempering operation usually extended over two hours or more per lot, and other duties had to be attended to in the meanwhile, I found it almost impossible to keep it in mind sufficiently to watch the thermometer as it should be watched, and as a result was obliged to re-harden several lots, on account of allowing the heat to go too high. This annoyance led me to devise an automatic alarm.

This alarm was made by using a piece of ⅛-inch gas pipe about 17 feet long, and welded tight at one end. The pipe was then coiled by wrapping it around an old pulley and spreading it like an open-wound helical spring, so that it started in the bottom of pail *C* and ran around and close to the inside to nearly the top, where the end was bent to stand up straight, as shown at *G*. This tube was filled nearly full of mercury, care being taken to get all the air out. When the temperature in the pail rises, the mercury expands, and, rising in the tube *G*, makes a contact with the adjustable wire A_1 (Fig. 2). One wire from an electric bell is attached to the clamp B_1, carrying a binding post, and is insulated from the coiled pipe by the hard rubber collar-bush C_1. The small bush D_1 near the end of the wire A_1 is a loose fit in the tube G_1. The other wire to the bell is connected to the pipe coil at E_1.

After a few trials and by using the thermometer as a standard, the wire A_1 may be graduated to the temperatures mostly used. This makes a very efficient alarm, and once the work is in the pail and the fire lighted, no further thought need be given it until the bell rings, when anyone can turn out the flame.

The writer was at one time engaged in a place where many thousands of steel pieces were regularly manufactured, all of them being hardened. The work was all similar and less than half the product was tempered after hardening, while the main and cheaper part of the product was not tempered because of the prohibitive cost. In this place an experienced man, by the use of a large hot plate placed over a furnace, did about 400 pieces in 10 hours. The highest day's work ever done was 500 pieces, and the man was nearly roasted to death, especially in hot weather. After getting permission from the firm I secured an ordinary caldron kettle, such as farmers and butchers use, and made a fire under it with hard coal. Over the kettle was fitted a galvanized-iron hood with a pipe leading outside to carry off the smoke and fumes from the hot grease. Inside the kettle which was filled with tallow was a large perforated pail corresponding to *F* (in Fig. 1) which held the work. The temperature was regulated by a long stem-pitching machine thermometer made by Schaeffer & Budenburg of Brooklyn, N. Y.

With this device the man was not only able to do about 1500 pieces in a few hours, but did them in such a superior manner that going back to the old method was not thought of. It will be found absolutely necessary with this device to use the hood and pipe for carrying off the smoke from the oil unless the apparatus is used in the open air.

The hardening and tempering of the tools used in manufacturing operations are among the most important operations through which they pass in the making; and yet these operations seem to be least understood generally by those who make tools. The facilities for hardening and tempering are in most shops precisely the same as were used at the beginning of the manufacturing. I think it perfectly safe to say that between a cutting tool imperfectly hardened, and one done in the best possible way, the efficiency is 1 to 5. Some of the manufacturers of such tools as drills, taps, dies, milling cutters, etc., are alive to the necessity of advancement along this line, and provide the most efficient and up-to-date hardening devices, but the large majority of them and nearly all the toolrooms which make tools for their own use, employ the "good old methods."

Toolmakers, in general, are only just beginning to wake up to the fact that it takes an expert in steel to tell anything but the size of the grain from the fracture; and that the size of the grain tells nothing but the degree of heat to which it was raised in hardening. This is no guide whatever to the quality of the steel, and is of no importance except to tell that the steel is hardened and ready to use. The heat also should never be higher than will give the required degree of hardness with little or no drawing, and the drawing should be done evenly and slowly. This enables the molecules to settle, and thus relieve the strains set up in the hardening process.

* * *

The man who knows more than the boss usually gets to be the boss. The man who only "thinks" he knows more than the boss usually gets fired.—*Exchange*

* Address: 39 Clinton Ave., Plainfield, N. J.

A SIMPLE ROUTING SYSTEM

HOW THE PARTS OF THE LUCAS BORING MACHINE ARE PUT THROUGH THE SHOP

Of shop systems, like books, there is no end, and again like books, there are good and bad systems. Any shop system must be judged by what it accomplishes and the cost of its administration. The simpler a system, other things being equal, the better it is when judged from the practical man's point of view. The following system of routing work through a machine shop is that used in the building of horizontal boring machines by the Lucas Machine Tool Co., Cleveland, Ohio, and is commended for its simplicity and the complete control and knowledge of the progress of work through the shop.

The detail drawings are made on sheets 19½ by 26 inches. The sheets are divided into sections, the size varying according to the size of the parts shown. The largest number of divisions of the sheet is sixteen, these being obtained by three horizontal and three vertical lines. This size is used only for the small simple details that can be clearly delineated in the available space. In all, there are five sizes of divisions up to and including one-half the sheet. The scheme is illustrated in part in Fig. 1. At the bottom, space is reserved for the operation numbers and records of progress.

Two blue-prints are made of each group of details in the drawing room and issued for each lot of twenty-four machines. One print is made of paper and is kept in a binder in the shop office. The other print is made on cloth and is cut apart, making as many individual prints as there are separate details on the sheet. These are punched at the top and provided with a ring to which is attached a routing tag. The routing tag is filled out in the shop office and sent into the shop with its blue-print to accompany the parts until finished and delivered to the assembling floor or the storeroom.

For the purpose of illustration the 4-pitch 23-tooth first driving bevel gear has been chosen. This detail, shown on the sheet Fig. 1, is shown detached in Fig. 2 with its routing tag attached. The symbol of this part on the drawing is 32—139, in a circle. The first number is the machine number and the second is the pattern number, in case the piece is a casting. Each operation for each piece on the sheet is designated in the operation sheet at the bottom of Fig. 1, in the spaces opposite the part symbol. The operations on the chosen piece are 12-a, 12-b, 13, 16, 24, 9, 15 and 20, these being "turret chuck" (a and b) gear cutter," "keyseater" "storeroom," lathe," milling machine," and "fitting" as will be seen in the accompanying schedule of operation numbers.

It will be noted that this schedule gives the name of the operation in some cases, but in more it gives the name of the machine. The reason for this is that the individual operations on the lathe, milling machine, etc., are minutely specified in separate lists that accompany the routing tag and blueprint when required to follow out the order that has been determined in the planning department. These lists of operation are typewritten and blue-printed, and are pasted on the back of the shop blue-prints.

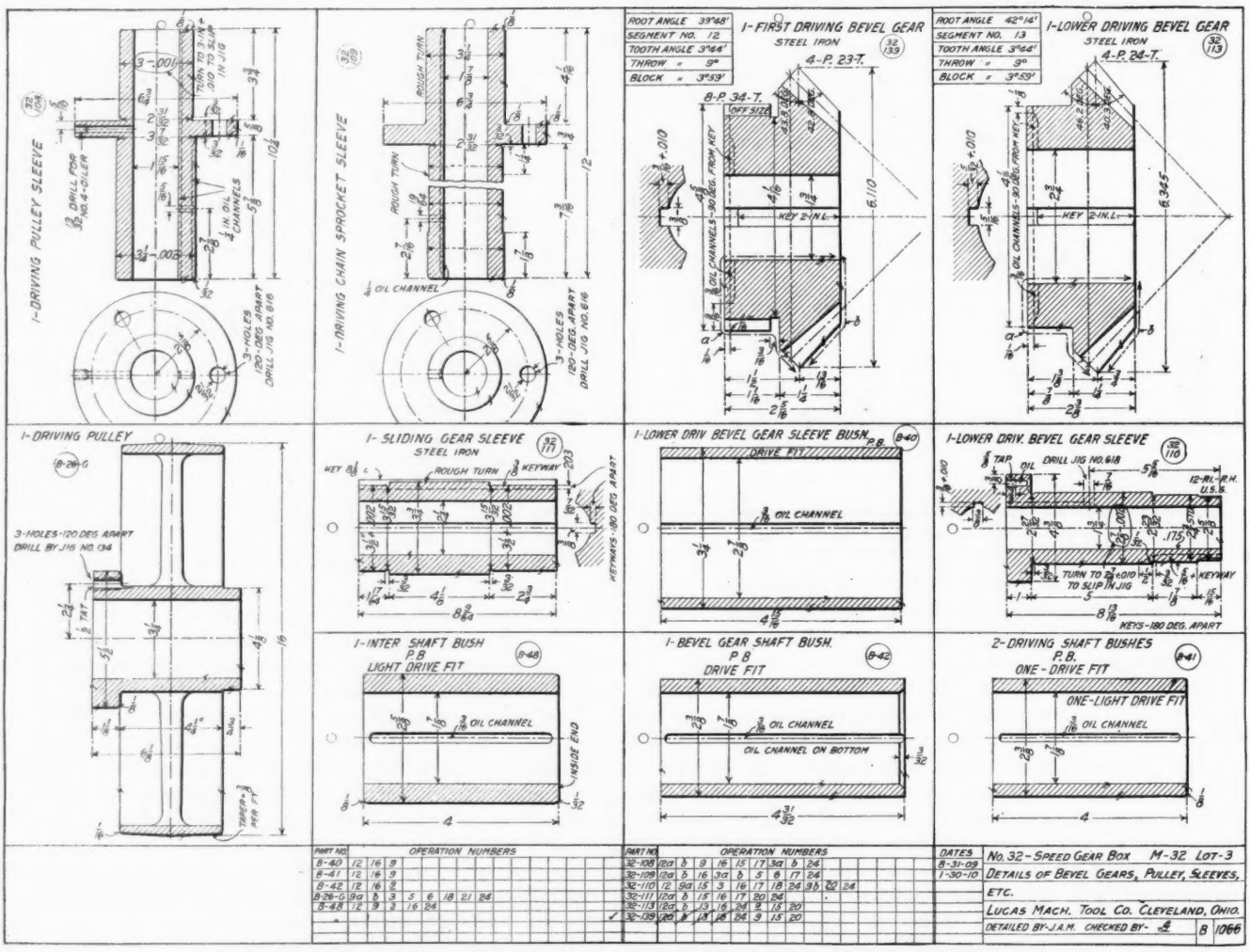

1-DRIVING PULLEY SLEEVE
1-DRIVING CHAIN SPROCKET SLEEVE
1-FIRST DRIVING BEVEL GEAR
STEEL IRON
4-P. 23-T.
8-P. 34-T.
1-LOWER DRIVING BEVEL GEAR
STEEL IRON
4-P. 24-T.
1-DRIVING PULLEY
1-SLIDING GEAR SLEEVE
STEEL IRON
1-LOWER DRIV BEVEL GEAR SLEEVE BUSH P.B.
DRIVE FIT
1-LOWER DRIV. BEVEL GEAR SLEEVE
1-INTER SHAFT BUSH
P.B.
LIGHT DRIVE FIT
1-BEVEL GEAR SHAFT BUSH.
P.B.
DRIVE FIT
2-DRIVING SHAFT BUSHES
P.B.
ONE - DRIVE FIT
ONE - LIGHT DRIVE FIT
OIL CHANNEL
OIL CHANNEL ON BOTTOM
KEYWAY
KEYS-180 DEG. APART
3-HOLES-120 DEG. APART
DRILL JIG NO. 6/6
DRILL JIG NO. 134
ROUGH TURN
INSIDE END
TAPER ¾ PER FT.
PART NO. OPERATION NUMBERS
8-40 12 16 9
8-41 12 16 9
8-42 12 16 9
8-26-G 9a b 3 5 6 18 21 24
8-48 12 9 3 16 24
32-108 12a b 9 16 15 17 3a b 24
32-109 12a b 16 3a b 5 8 17 24
32-110 12 9a 15 3 16 17 18 24 9b 20 24
32-111 12a b 15 16 17 20 24
32-113 12a b 13 16 24 2 18 20
32-139 12a b 13 16 24 9 15 20
DATES
8-31-09 No. 32 - SPEED GEAR BOX M-32 LOT-3
1-30-10 DETAILS OF BEVEL GEARS, PULLEY, SLEEVES, ETC.
LUCAS MACH. TOOL CO. CLEVELAND, OHIO.
DETAILED BY-J.A.M. CHECKED BY-
8 1066

Fig. 1. Detail Drawing, Lucas Machine Tool Co., showing Operation Numbers and Record of Progress

OPERATION NUMBERS

1.—Planing	9.—Lathe	19.—Scraping
2.—Boring Machine	10.—Lo-swing Lathe	20.—Fitting
3.—Drilling Machine	11.—Turret Bar	21.—Miscellaneous hand work
4.—Helping	12.—Turret Chuck	22.—Erecting
5.—Cleaning Castings	13.—Gear Cutter	23.—Inspecting
6.—Painting (including filling and rubbing)	14.—Thread Milling Machine	24.—Store Room
7.—Cutting off	15.—Milling Machine	25.—Graduating
8.—Centering.	16.—Keyseater	26.—Spindle Boring Machine
	17.—Grinder	27.—Auto. Turret Machine
	18.—Polishing	

The first operation on the bevel gear blank is chucking in the Gisholt turret lathe and performing operation a. This operation is boring, facing and turning the surfaces designated by the line *a* in the drawing, which starts in the bore

and terminates at the outer angle of the tooth section. This line is broken, the break being one short dash. One short dash indicates that it is the first operation. The second operation b is indicated on the drawing by another broken line *b*, the break consisting of two short dashes. Of course, the operator on the turret lathe does not change from one operation to the other on each piece. He does one operation on each piece first and then changes his chuck and tools to do the second operation, and so on.

When the lot of castings and the routing tag are delivered to the turret lathe, a check mark is made by the clerk on the shop office drawing, opposite the symbol. This mark shows

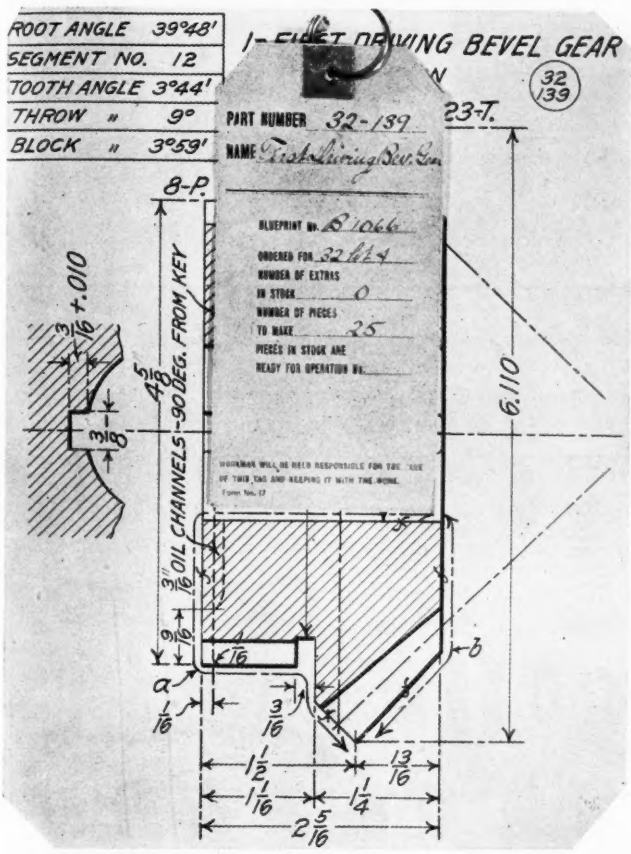


Fig. 2. Detached Detail Drawing with Routing Tag Attached

that work has been started on these parts. Further records are made from the cost cards, a sample of which is shown in Fig. 3. The cost cards are of the regular form supplied by the International Time Recorder Co., and are stamped in a time recording clock when the job is started and when completed. They are partly filled out by the shop office clerk, the order number, piece number, operation and number of pieces being the items entered. The cards then go to the foreman who keeps them in a card rack with index tab cards to designate the various operations. Thus there will be cards for practically all the operations enumerated on the schedule of operations.

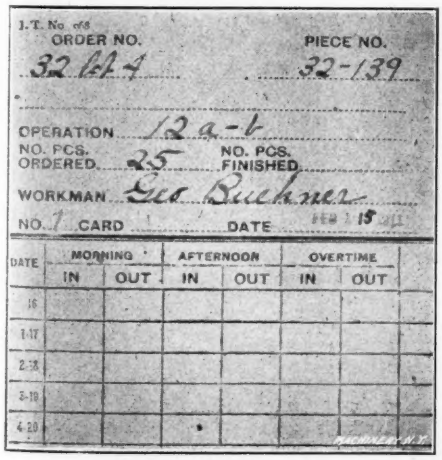


Fig. 3. Top Portion of a Cost Card

The turret lathe operator who machined the bevel gear blanks was charged with twenty-five pieces, an extra piece being supplied to replace any casting found defective or spoiled. When he finishes operation 12-a and 12-b, the time of completion is stamped in the time recorder, and the card is turned in to the foreman, who then gives the workman another job, and the cost card for the operation is stamped in the "In" column. The cards for completed operations are collected each morning, and the completed operations are marked off on the shop office blueprints as indicated in Fig. 1 for operations 12-a and 12-b. The same is being done for all the other parts on this sheet

PART NUMBER 32-139
NAME First Driving Bev. Gear
BLUEPRINT No. B 1066
ORDERED FOR 32 bl 4
NUMBER OF EXTRAS
IN STOCK 0
NUMBER OF PIECES
TO MAKE 25
PIECES IN STOCK ARE
READY FOR OPERATION No.
WORKMAN WILL BE HELD RESPONSIBLE FOR THE CARE OF THIS TAG AND KEEPING IT WITH THE WORK.
Form No. 17
OPERATION NUMBER
No. Pieces Received
No. Rejected Rock Material
No. Pieces Spoiled
No. Pieces Delivered
Checked and Inspected
12 a-b 25 0 0 25 SS
13 25 1 0 24 FY
16 24 0 0 24 FY
24 24 24 CR
9 24 24 EH
15 24 24 LR
20 24 24 ME

Figs. 4 and 5. Front and Back of Routing Tag

and on the other sheets for the lot of machines going through.

When the turret lathe man completes the lot of bevel gear blanks and so reports to his foreman, the report means to the shop office that the lot has been delivered to the machine for the next operation. An order is not considered complete until the delivery is made.

The next operation in this case is gear cutting. Twenty-five turned and bored blanks are delivered to the gear cutting department together with the routing tag and blue-print, Fig. 2. The operator to whom they are turned over stamps the time of beginning in the "In" column of a cost card filled out for operation 13, and when the lot is completed the time is stamped in the "Out" column as before. In this case one blank was found defective when cut and twenty-four perfect gears were turned over to the keyseater for operation No. 16. The next morning the cost card went into the shop office and operation 13 was checked off on the shop office record blue-print.

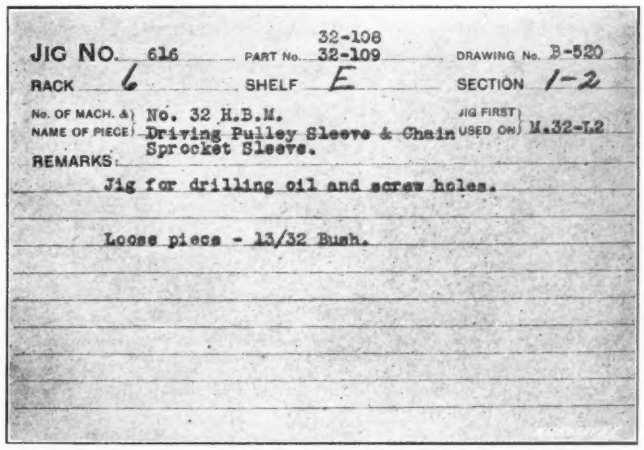

JIG NO. 616
PART No. 32-108 32-109
DRAWING No. B-520
RACK 6
SHELF E
SECTION 1-2
No. OF MACH. & NAME OF PIECE No. 32 H.B.M. Driving Pulley Sleeve & Chain Sprocket Sleeve.
JIG FIRST USED ON M.32-L2
REMARKS:
Jig for drilling oil and screw holes.
Loose piece - 13/32 Bush.

Fig. 6. Sample Index Card showing Location of a Jig in the Tool-room

The orders for castings also originate in the drawing office, and the prints are not issued to the shop office until the castings are delivered by the foundry. The drawings are made to convey all necessary instructions to the workmen. Thus when parts are to be drilled or bored in jigs, the jig number is given on the drawing. For example, the driving pulley sleeve and driving chain sprocket sleeve, symbols 32—108 and 32—109, are drilled in jig No. 616. This jig will be found in the

tool-room in rack 6, on shelf E, in section 1—2. The description of the jig and location are given on a card, Fig. 6, kept in a card index in the tool-room.

From this outline it will be understood that a constant record is available in the shop office which shows from day to day the progress of work on any lot of machines and the location of all parts. It also shows the number of parts spoiled and indicates on what operation they were spoiled. The costs can be calculated for a machine or lot of machines in any stage of construction. The system is much more quickly comprehended than described, and its simplicity is shown by the fact that one clerk attends to all its details after receiving the blue-prints from the drawing office. F. E. R.

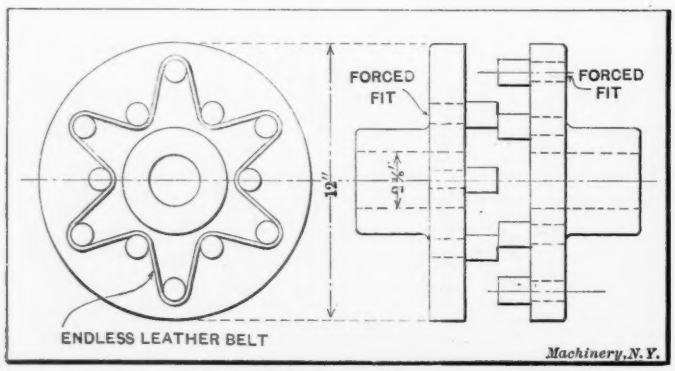
* * *

ELIMINATION OF LINESHAFT VIBRATION

By R. S. F.

The vibration coupling shown in the accompanying illustration has no doubt been known to the majority of practical men for a long time, and the writer does not lay any claim whatever to its invention. However, the success attending its use where an exceedingly heavy load had to be started by a direct-connected motor (due to the shaft vibration given by the device allowing the motor to get fairly started before the full load came upon it), suggested its use for the case to be described.

A new machine shop, 60 feet wide by 175 feet long, of an all-steel construction, with reinforced concrete gallery floors and roof, was equipped with two 40-horsepower motors. One of these was suspended from steel I-beams under the gallery and was direct-connected by cone vise couplings to a jack-shaft on which were located two pulleys, each driving a lineshaft, also suspended under the gallery in like manner as the motor, and extending the full length of the shop. The other motor was located directly above the gallery, suspended from the roof under exactly the same conditions. These motors when put in operation driving planers, slotters, shapers, etc., where the load is very intermittent, caused such a vibration on the



Coupling used to eliminate Vibration in a Lineshaft suspended from a Concrete Structure

gallery floor that it was impossible to work there with any degree of comfort. In addition, the concrete work developed large cracks in a very short time.

To remedy these troubles, the couplings shown in the engraving were installed in place of the cone vise couplings. This resulted in the total elimination of all vibration, much to the comfort of the workman, as well as materially reducing the wear and tear on the concrete work. In relating this incident, the writer does not condemn, of course, the cone vise or similar forms of couplings when used under ordinary circumstances, but strongly advises its elimination where conditions similar to the ones referred to above prevail.

It will be noticed that the two coupling sections are shown apart, for clearness, in the illustration. In operation, of course, the ends of the projecting pins are close to the opposite faces of the flanges.

* * *

It is mentioned in the *Times Engineering Supplement* that a steel chimney 56 feet high and 4 feet 3 inches in diameter was recently put together entirely by electric welding, and completed before erection. It was erected in about three hours. This is, so far as we know, a new use for electric welding.

MAKING "DIAMOND" AUTO TRUCK CHAIN

The first means for transmitting rotary motion from one wheel to another very likely was a cord, then a belt of leather, and then, for still greater power, a metal chain. The use of chain for power transmission dates back many years, the first forms being ordinary round iron link chain working on cast-iron sheaves made with smooth wedge-shaped grooves or with pockets for the chain links The malleable detachable

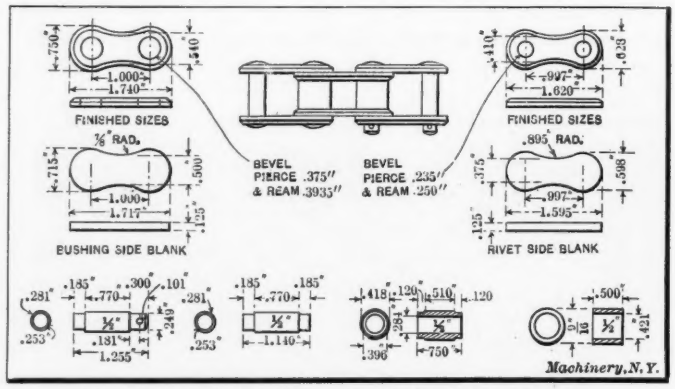


Fig. 1. Diamond Roller Chain No. 155 for Auto Trucks, etc.

link chain now so largely used on conveying and other rough machinery was a great improvement over the older form in point of efficiency and durability, but it was not until the advent of the bicycle that really high-grade transmission

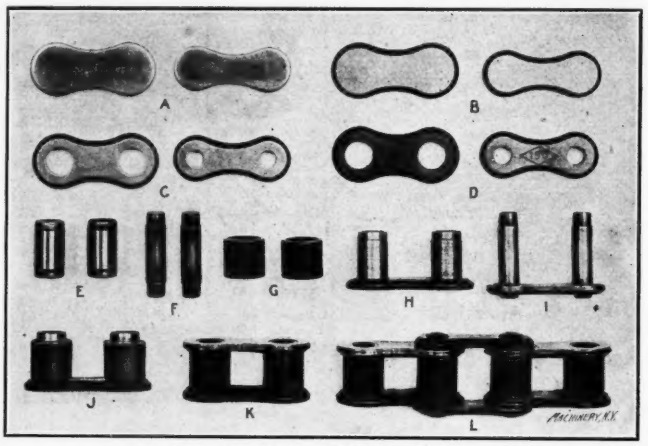


Fig. 2. Parts of Diamond Roller Chain No. 155

chain of uniform pitch, fitted to accurately-cut sprocket wheels, was put on the market as a regularly manufactured product. This light chain was used for many purposes other than the bicycle, and heavier sizes were manufactured to

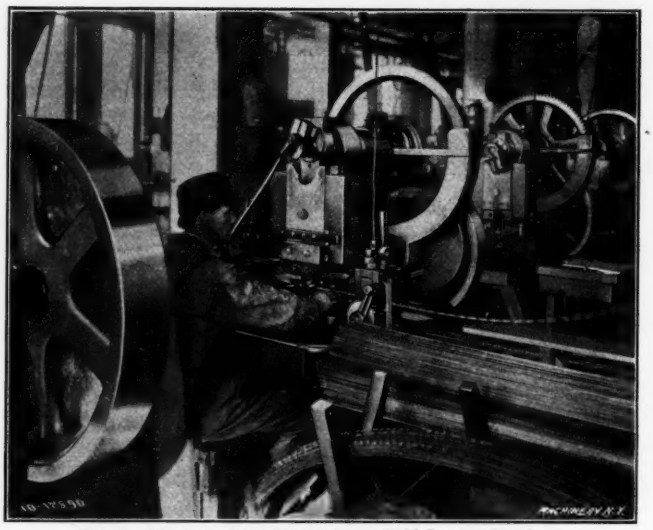


Fig. 3. Blanking Side Pieces from Cold Drawn Stock

meet the demand, but the development of the automobile and auto trucks made the market for heavy high-grade chain, most of which is now provided with rollers to reduce the friction of engagement and release of the chain links and sprocket teeth. The following article illustrates the main

features of the practice of the Diamond Chain & Mfg. Co., 240 W. Georgia St., Indianapolis, Ind., in making heavy power transmission chain of the roller type.

The company was organized in 1890 when the bicycle was at the height of its popularity. For several years the product was bicycle chain exclusively, but with the development of the automobile, the auto truck and other machinery requiring heavier high-grade power transmission chain, the line has been extended, until now forty-eight distinct styles, sizes and weights are listed in its catalogue for all kinds of service. Highly developed special machinery for making bicycle chain is in use, the quantity of this chain produced every year being so great that a large investment in machinery for its manufacture is warranted. But for making auto truck chain comparatively little special machinery is employed, the quantity of any one size used being too small, perhaps, to pay returns on the cost of the heavy machinery that would be required if the bicycle chain equipment were duplicated. The present article, therefore, illustrates and describes more or less common machines and operations which derive interest chiefly from the product.

One size of chain, No. 155, has been taken to illustrate the steps of manufacture. This size is made in three widths, ⅜-, ½- and ⅝-inch, respectively. The working drawing, Fig. 1, shows the parts and dimensions of the bushing side piece, rivet side piece, rivet, bushing and roller of the ½-inch size; also the dimensions of the connecting rivets, one pair of which with spring cotters, must, of course, be furnished with every chain. Fig. 2 illustrates the parts in the following stages of manufacture: *A*, bushing and rivet sides blanked; *B*, bushing and rivet sides with edges beveled; *C*, bushing and rivet sides punched; *D*, bushing and rivet sides reamed and blued; *E*, finished bushings; *F*, finished rivets; *G*, finished rollers; *H*, assembled bushings; *I*, assembled rivets; *J*, assembled bushing and rollers; *K*, assembled roller link complete; *L*, section of completed chain.

The chain side blanks are punched from cold-drawn 20 to 40 point carbon steel strips, 0.125 by 0.875 inch for the bushing sides, and 0.125 by 0.750 inch for the rivet sides. By "bushing sides" and "rivet sides" are meant the parts in which the bushings and rivets are tightly fitted. Fig. 3 shows the style of press, and the roller feed which is typical of the feed used on all the heavy perforating presses.

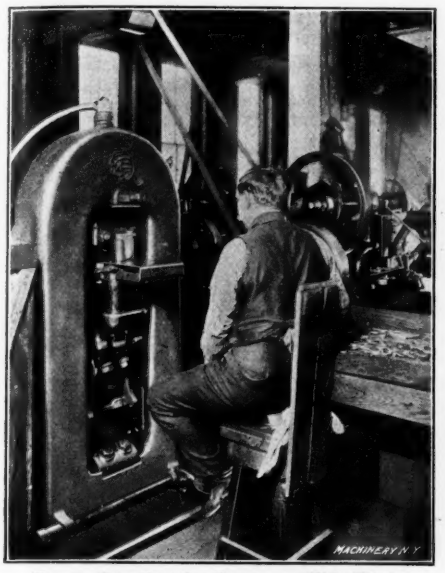


Fig. 4. Beveling the Corners of Side Pieces in Coining Press

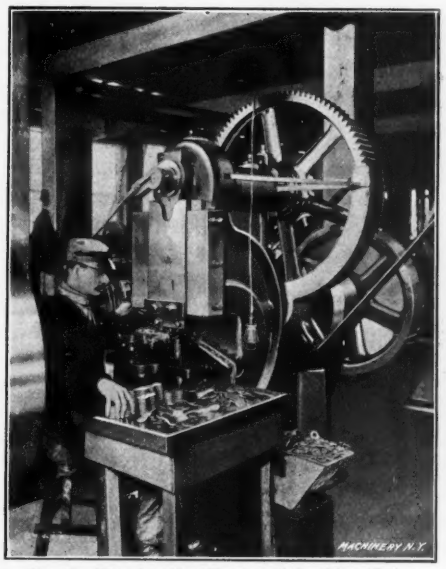


Fig. 5. Piercing the Rivet and Bushing Holes in Side Pieces

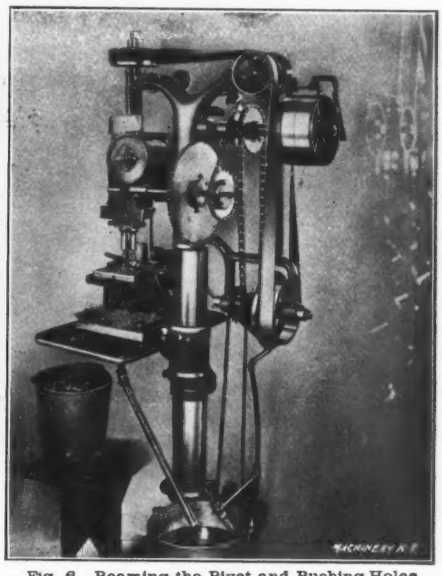


Fig. 6. Reaming the Rivet and Bushing Holes in Side Pieces

The second operation is beveling the sides of the blank, which is done on a Ferracute coining press, Fig. 4. The blanks are automatically fed to the dies by a slide which pushes the blanks from the bottom of the small magazine shown in front. The coining operation produces a smooth beveled surface with sharp corners and hardly perceptible flow of the metal, and is a rapid and satisfactory way to bevel the edges of the parts. In passing, it may be noted that this coining operation, while one of the oldest methods of forming designs, is strangely neglected as a method of producing many shapes that are now generally produced by profile milling. Where the number of pieces runs into thousands, there is little doubt that forming by heavy pressure could often be profitably substituted for the common method of removing stock by rotating or other cutting tools.

The holes are punched after the coining operation, as shown in Fig. 5, both holes, of course, being punched at once. Square-faced punches are used for blanking and punching in order to produce the parts with a minimum of twist. Punching the hard stock with the square-faced punches is heavy work, and heavy gap punching machines are employed. The

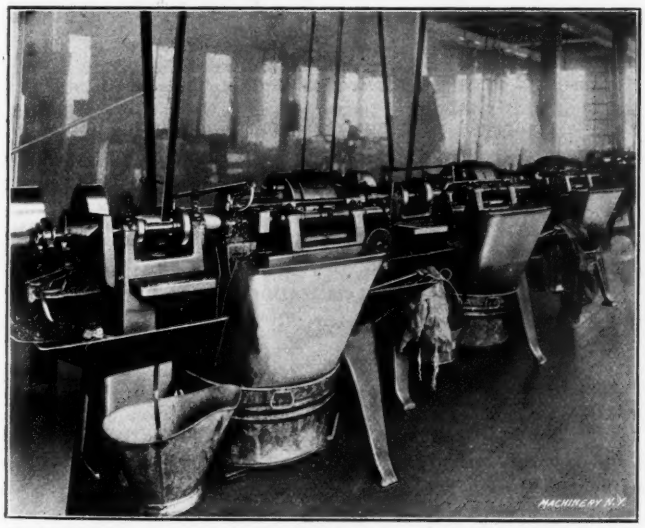


Fig. 7. Section of Screw Machine Department, 185 Screw Machines in Use

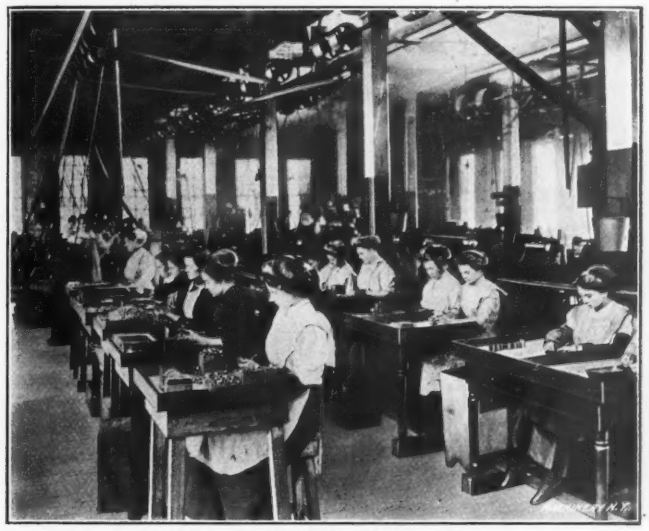


Fig. 8. Gaging Screw Machine Work

stock is fed by a roller feed operated by a ratchet, which automatically releases it at the moment when the punch descends.

The holes are reamed in jigs on semi-automatic machines, one of which is shown in Fig. 6. Reaming the holes is an important feature of the manufacture of high-grade machinery chain. It insures accuracy of size, which is necessary for snug and even bearing on the bushings and rivets, and accuracy of pitch—a very important consideration. Incidentally, the illustration Fig. 6 shows the advantageous use of chain transmission in machine tools, and is only one of many uses to which power transmission chain is applied in the factory. After reaming, the trade-mark and number are stamped on the rivet side pieces, this being the last machine operation before bluing.

Fig. 9. Assembling Bushings and Bushing Side Pieces

The rivets, bushings and rollers are made on automatic screw machines, mostly "Clevelands," a section of one battery of which is shown in Fig. 7. An idea of the number of these screw machine parts used is conveyed by the fact that 185 screw machines are in use. The rollers are casehardened, brightened by tumbling, and toughened by drawing to a straw color. The bushings are casehardened, and tumbled to remove the scale and left hard, without further finish. The rivets of chain No. 155 are nickel steel hardened and drawn to a blue on the ends only, which must be left soft for riveting over.

Fig. 10. Assembling the Chain

The limits of variation of the product are close, and to insure that the high standard is maintained, the parts, running into many thousands daily, are gaged by girls. A view of the gaging department is shown in Fig. 8. The gaging of the parts is regulated by the size of the chain and its grade. Every part of No. 155 is gaged, as is the case with other high grades. Smaller and cheaper chain is gaged by testing the parts regularly, thus maintaining a check on the general character of the product.

When the link parts are completed, they are assembled by hand, machines being used to force the rivets and bushings into the side plates. The order of operations is as follows: The rivets and rivet sides, and the bushings and bushing sides are first assembled in dial feed presses, as shown in Fig. 9. The operators supply the sides to small magazines and set the rivets or bushings in the dials as they revolve. When the revolution brings a pair under the press they are forced into the side piece that has been carried from the magazine around with the dial. The rivets and bushings are thus pressed into the sides, forming the "assembled bushings" and "assembled rivets," *G* and *H*, of Fig. 2. The rollers are assembled on the bushing assembly by girls, making the combination shown at *I*, Fig. 2, and then the complete chain assembly is made, as illustrated in Fig. 10. The sides are forced onto the bushings and rivets by the power press, as stated.

The final, but by no means the least interesting, operation is spinning the rivets on the automatic double-spindle machine shown in Fig. 11. Both ends of the rivets are spun simultaneously, the operation being one of the quickest and neatest in the making of the chain. After the final inspection and testing, the chain is ready for the market.

This chain, the making of which was described in the foregoing, is composed of about sixty parts per lineal foot. All the parts are accurately formed, beautifully finished, and part of them are hardened and tempered. The finished chain weighs about one-half as much as the raw stock required for its manufacture, yet the retail price is about $1 per foot. The possibility of manufacturing this product at the price, is due to automatic machinery, specialization of workmen and thorough organization of manufacture throughout. F. E. R.

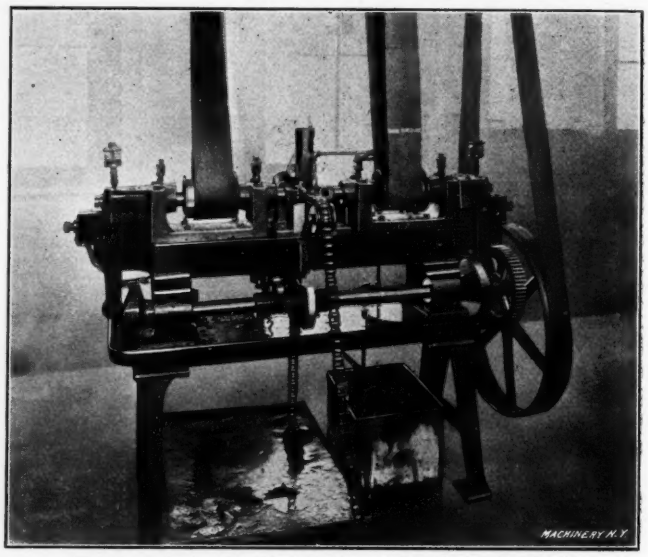


Fig. 11. Spinning the Rivet Ends and Completing the Chain

* * *

MAKING HAND-TAPS IN SETS

When hand-taps are made in sets of three, the first and second tap not cutting a full thread, but only partially completing the thread, which is finished by the third tap, it is of considerable importance that the relative diameters of the three taps are so proportioned that the two roughing taps each cut a fair amount of the thread, and that the finishing tap is required to do but comparatively little actual cutting, merely taking a shaving cut.

A simple rule used by one tap manufacturer for United States standard thread taps, and which has been found to give entire satisfaction, is to make the diameter of the first tap in a set equal to the diameter of the finishing tap less the depth of the thread, and to make the diameter of the second tap in a set equal to the diameter of the finishing tap less one-third of the depth of the thread. This makes the actual depth of the thread of the two roughing taps equal to one-half and five-sixths of the depth of the finished thread, respectively, and leaves but a small amount of metal to be removed by the finishing tap.

SHRINKAGE AND FORCED FITS—2

By WILLIAM LEDYARD CATHCART*†

The *total* allowance for shrinkage is the difference between the external diameter of the inner member (shaft) and the internal diameter of the outer (hub), before shrinkage. The *unit* shrinkage-allowance is the allowance per inch of nominal diameter, in either case, as above; and also, in either case, the *unit* deformation of a given circumference or diameter is the difference between its lengths before and after shrinkage, divided by its original length. The principle which is applied in the derivation of formulas for shrinkage-allowances, is that

TABLE III

Values of Ratio C for solid steel shafts of nominal diameter D_1, and hubs of steel or cast-iron of nominal external and internal diameters D_2 and D_1, respectively.

Ratio of Diameters $\frac{D_2}{D_1}$	$C=\frac{T_1}{T_2}$		Ratio of Diameters $\frac{D_2}{D_1}$	$C=\frac{T_1}{T_2}$	
	Steel Hub	Cast-iron Hub		Steel Hub	Cast-iron Hub
1.5	0.227	0.234	2.8	0.410	0.432
1.6	0.255	0.263	3.0	0.421	0.444
1.8	0.299	0 311	3.2	0.430	0.455
2.0	0.333	0.348	3.4	0 438	0.463
2.2	0.359	0.377	3.6	0.444	0.471
2.4	0.380	0.399	3.8	0.450	0.477
2.6	0.397	0.417	4.0	0.455	0.482

the unit-deformation at any point is the quotient of the unit stress at that point, divided by the modulus of elasticity. In a shrinkage fit, the unit-deformations considered are those at the fit, and the unit-stress to which these deformations correspond are manifestly the "true" or actual stresses, and not those which have been termed "apparent" since, as has been shown, the effect of lateral contraction is important.

The length of a given circumference varies directly as that of its diameter. Hence the unit-deformation will be the same for both, and this deformation, when due to the true tangential stress in the hub at the bore, will be the unit-deformation of the internal diameter of the hub. Similarly, for both solid and hollow shafts, the unit-deformations of the external diameters are those of the circumferences of their outer surfaces, produced by the true tangential stresses there, since that circumference and the external diameter decrease together. The unit-deformation of the external diameter of the inner face will serve only for a solid shaft, since in it, as shown in Fig. 4 (April issue) the tangential and radial stresses are equal at all points from the circumference to the center, while, in the hollow shaft, the intensity of the radial stress varies from P_1 at the outer surface to zero at the bore, and hence the deformation due to this stress at any given point is that corresponding only with the infinitely small element of radius in which that stress exists, and not with the average unit-deformation of the whole radius.

The formulas below have been deduced for calculating the allowances required for shrinkage fits with given stresses. Let

T_1 = true tangential compressive stress at outer surface, inner member.

T_2 = true tangential tensile stress at inner surface, outer member,

R_1 = radius of fit.

R = actual internal radius of outer member before expansion.

R' = actual external radius of inner member before compression,

S = unit shrinkage-allowance $= \frac{R'-R}{R}$,

The values of C for various diametral ratios are given, for solid steel shafts with steel or cast-iron hubs in Table III; and, similarly, for hollow steel shafts, in Tables IV and V.

The modulus of elasticity for steel is assumed as 30,000,000, and for cast iron as 15,000,000. Then, for a cast-iron hub and a steel shaft:

$$S=\frac{T_2\,(2+C)}{30{,}000{,}000} \qquad (22)$$

$$S=\frac{T_1(2+C)}{C\times 30{,}000{,}000} \qquad (23)$$

and, for both hub and shaft of steel:

$$S=\frac{T_2\,(1+C)}{30{,}000{,}000} \qquad (24)$$

$$S=\frac{T_1\,(1+C)}{C\times 30{,}000{,}000} \qquad (25)$$

Calculating Shrinkage Fits

In designing shrinkage fits, there are but two main principles to remember. First, the stress in the hub at the bore, which is the most important consideration, depends chiefly on the shrinkage-allowances. If the latter be too large, the elastic limit will be exceeded and permanent set will occur; or, in extreme cases, the ultimate strength of the metal will be passed and the hub will burst. Second, the intensity of the grip of the fit, and hence the resistance of the latter to slip, depends mainly on the thickness of the hub. The greater this thickness, the stronger the grip, and *vice versa*. The information required in designing can be obtained as follows:

TABLE IV

Values of Ratio C for hollow steel shafts of external and internal diameters D_1 and D_0, respectively, and steel hubs of nominal external diameter D_2.

$\frac{D_2}{D_1}$	$\frac{D_1}{D_0}$	C	$\frac{D^2}{D_1}$	$\frac{D_1}{D_0}$	C
1.5	2.0	0.455	2.8	2.0	0.820
	2.5	0.357		2.5	0.645
	3.0	0.313		3.0	0.564
	3.5	0.288		3.5	0.519
1.6	2 0	0.509	3.0	2.0	0.842
	2.5	0.400		2.5	0.662
	3.0	0.350		3.0	0.580
	3.5	0.322		3.5	0.533
1.8	2.0	0.599	3.2	2.0	0.860
	2.5	0.471		2.5	0.676
	3.0	0.412		3.0	0.591
	3.5	0.379		3.5	0.544
2.0	2.0	0.667	3.4	2.0	0.876
	2.5	0.524		2.5	0.689
	3.0	0.459		3.0	0.602
	3.5	0.422		3.5	0.555
2.2	2.0	0.718	3.6	2.0	0.888
	2.5	0.565		2.5	0.698
	3.0	0.494		3.0	0.611
	3.5	0.455		3.5	0.562
2.4	2.0	0.760	3.8	2.0	0.900
	2 5	0.597		2.5	0.707
	3.0	0.523		3.0	0.619
	3.5	0.481		3.5	0.570
2.6	2.0	0.793	4.0	2.0	0.909
	2.5	0.624		2.5	0.715
	3.0	0.546		3.0	0.625
	3.5	0.502		3.5	0.576

a. For a given allowance per inch of diameter, the true tensile stress T_2 in the hub at the bore can be found from Equations (22), or (24). These equations hold only up to the elastic limit. It will be seen that by increasing or de-

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creasing the allowances, any stress up to this limit can be produced at the bore, and this stress will be the maximum tensile stress in the hub.

b. Equation (3) and Table I show the relation between the true tensile stress in the hub at the bore and the radial pressure on the fit. There are several factors which govern the intensity of this radial pressure: the magnitude of the allowances, the compressibility of the inner member, and the expansibility of the outer. The two latter depend on the metals; the last is affected by the thickness of the hub.

c. When T_2 is known, the value of P_1 can be obtained from Table I.

d. The true tangential compressive stress T_1 at the outer surface of the inner member is usually of minor importance in design. The true radial compressive stress at the surface is equal to the radial pressure P_1 minus the product of ϕ_1 by the value of t_1, as given by (4) and (10).

e. At the bore of a hollow shaft, the radial pressure is zero. Equation (9) gives the true tangential compressive stress.

f. The intensity of the apparent stresses is, in general, of academic interest only.

Example 1.—A steel crank-web, 15 inches least outside diameter, is to be shrunk on a 10-inch solid steel shaft. Required the allowance per inch of shaft-diameter to produce a maximum tensile stress in the crank of 25,000 pounds per square inch, assuming the stresses in the crank to be equivalent to those in a ring of the diameter given.

$\frac{D_2}{D_1} = \frac{15}{10} = 1.5$; $T_2 = 25{,}000$. From Table III, $C = 0.227$. Substituting in Equation (24), we find $S = 0.001$ inch.

TABLE V

Values of Ratio C for hollow steel shafts and cast-iron hubs. Notation as in Table IV.

$\frac{D^2}{D^1}$	$\frac{D^1}{D_0}$	C	$\frac{D_2}{D_1}$	$\frac{D_1}{D_0}$	C
	2.0	0.468		2.0	0.864
	2.5	0.368		2.5	0.679
1.5	3.0	0.322	2.8	3.0	0.594
	3.5	0.296		3.5	0.547
	2.0	0.527		2.0	0.888
	2.5	0.414		2.5	0.698
1.6	3.0	0.362	3.0	3.0	0.611
	3.5	0.333		3.5	0.562
	2.0	0.621		2 0	0.909
	2.5	0.488		2.5	0.715
1.8	3.0	0.427	3.2	3.0	0.625
	3.5	0.393		3 5	0.576
	2.0	0.696		2.0	0.926
	2.5	0.547		2.5	0.728
2.0	3.0	0.479	3.4	3.0	0.637
	3.5	0.441		3.5	0.587
	2 0	0.753		2.0	0.941
	2.5	0.592		2.5	0.740
2.2	3.0	0.518	3.6	3.0	0.647
	3.5	0.477		3.5	0.596
	2.0	0.798		2.0	0.953
	2.5	0.628		2.5	0.749
2.4	3.0	0.549	3.8	3.0	0.656
	3.5	0.506		3.5	0.603
	2.0	0.834		2.0	0.964
	2.5	0.656		2.5	0.758
2.6	3.0	0.574	4.0	3.0	0.663
	3.5	0.528		3.5	0.610

Example 2.—Let the shaft in Example 1 have a 5-inch axial hole bored through it, other conditions being the same. Find the unit-allowance.

$\frac{D_2}{D_1} = 1.5$, as before; $\frac{D_1}{D_0} = \frac{10}{5} = 2$; $T_2 = 25{,}000$. From Table IV we find $C = 0.455$.

Substituting in Equation (24), we find $S = 0.0012$ inch, the increase in the allowance being due to the fact that the hollow shaft is the more compressible of the two.

Example 3.—Let the crank-web in Example 1 be of cast iron and the maximum tensile stress in the hub be 4000 pounds per square inch. Find the unit-allowance.

$\frac{D_2}{D_1} = 1.5$; $T_2 = 4\,000$. From Table III, we find $C = 0.234$. Substituting in (22) $S = 0.0003$ inch, which, owing to the lower tensile strength of cast iron, is about one-third of the shrinkage-allowance in Example 1, although the stress is two-thirds of the elastic limit. For a forced fit, good practice gives (see Table VI) a unit-allowance of 0.0013 inch, or one-third greater than that of Example 1. The stresses which such an allowance would produce are, however, uncertain, as will be further discussed in the following.

TABLE VI. ALLOWANCES FOR FORCED FITS

Steel Shaft and Pin to Cast-iron Cranks. Average pressure required = 12.5 tons (of 2000 pounds) per inch of diameter.		Steel Shaft to Cast-iron Wheel-hubs. Average pressure required = 10 tons (of 2000 pounds) per inch of diameter.	
Diameter of Shaft, Inches	Allowance per Inch of Diameter	Diameter of Shaft, Inches	Allowance per Inch of Diameter
4	0.0030	12	0.0010
5	0.0024	13	0.0009
6	0.0020	15	0.0008
7	0.0017	17	0.0007
8	0.0015	18	0.0006
9	0.00135	19	0.00055
10	0.0013	22	0.0004
11	0.0012	23	0.00035
12	0.0010	24	0.0003
13	0.0010	26	0.00025
14	0.0010	27	0.0002
15	0.0010	....	.....
16	0.0009	....	.....
18	0.0008	....	.....
20	0.00075	....	.....

Example 4.—What is the radial pressure P_1 in the above examples?

For Examples 1 and 2, we find from Table I that $\frac{P_1}{T_2} = 0.341$. Hence,

$P_1 = 25{,}000 \times 0.341 = 8525$ pounds per square inch.

For Example 3, we find from Table I that $\frac{P_1}{T_2} = 0.351$. In this case $T_2 = 4000$, hence

$P_1 = 4000 \times 0.351 = 1404$ pounds per square inch.

Example 5.—What is the resistance to slip per inch of length of hub in Example 3?

In Equation (21), $D_1 = 10$, $L = 1$, and from Example 4 we have $P_1 = 1404$; f may be taken as 0.2. Then $Q = 8817$ pounds. which is the total resistance of a ring of the hub, one inch in length.

Example 6.—Let the crank in Example 3 be 20 inches least diameter, the other dimensions and the tensile stress remaining the same. Find the increase in the radial pressure P_1, and hence that in the resistance to slip.

In this case $\frac{D_2}{D_1} = 2$, Table I gives the ratio A, for this condition equal to 0.522, which is 49 per cent greater than the ratio $A = 0.351$ for $\frac{D_2}{D_1} = 1.5$. This percentage is the increase in radial pressure, and hence, that in the resistance to slip.

Example 7.—What is the true tangential stress (compressive) at the bore of the shaft in Example 2?

The radial pressure P_1 is, from Example 4, 8525 pounds. Substituting this value, and also $R_1 = 5$, and $R_0 = 2.5$ in Equation (9), the true stress $T_0 = 22{,}733$ pounds per square inch.

Example 8.—What is the intensity of the apparent tangential stresses in the crank and shaft, Example 1?

The radial pressure P_1 is, from Example 4, 8525 pounds. Substituting this value, and also $R_2 = 7.5$, and $R_1 = 5$ in Equation (1), the apparent tensile stress t_2 at the bore of the hub is 22,165 pounds per square inch. The similar compressive stress t_1 at the outer surface of the shaft is, from Equation (10), equal to P_1.

Shrinkage Temperatures

The temperature to which the outer member in a shrinkage fit should be heated for clearance in assembling the parts, depends on the total expansion required and on the coefficient a of linear expansion of the metal, *i. e.*, the increase in length of any section of the metal in any direction for an increase in temperature of 1 degree F. The total expansion in diameter which is required consists of the total allowance for shrinkage and an added amount for clearance.

The value of the coefficient a is, for nickel-steel, 0.000007; for steel in general, 0.0000065; for cast iron, 0.0000062. As an example, take an outer member of steel to be expanded 0.005 inch per inch of internal diameter, 0.001 being the shrinkage-allowance and the remainder for clearance. Then:

$$a \times t = 0.005$$

$$t = \frac{0.005}{0.0000065} = 769 \text{ degrees F.}$$

The value t is the number of degrees F. which the temperature of the member must be raised.

Cylindrical and Tapered Fits

The form of the shrinkage fit is usually truly cylindrical and of one diameter throughout; but both forced and shrinkage fits are, for some classes of work, either tapered or double-cylindrical, *i. e.*, with part of the fit of one diameter and part of another. The advantages of the tapered form in forced fits are: The possibility of abrasion of the fitted surfaces is reduced; less work is required to drive the inner member home; the drawings may be marked "Fit pin — inches from end of hole," which is the most trustworthy way of measuring the allowances; and the parts are more readily separated, if a renewal of the fit is desired. On the other hand, the difficulty of securing with accuracy the same form for both fitted surfaces, is somewhat greater; and the tapered fit is less reliable, since, if slip begins, the entire fit is virtually free with but little movement. These advantages and disadvantages apply also, but in less degree, to the double-cylinder form.

The practice of a prominent shipbuilding company, for both forced and shrinkage fits in either iron or steel, is: With large fits, both the inner and outer members have a taper of 1/16 inch to the foot; the allowances are 0.001 inch per inch of diameter with 0.001 inch added to the total. If the conditions are such that it is more convenient to ream the hole with standard parallel reamers, the inner member is tapered one half-thousandth inch (0.0005) per inch of length, unless the fit is so long that this taper would reduce the allowance at the small end to less than one-half that at the other extremity of the fit.

Differences between Forced and Shrinkage Fits

The formulas given in this article are based upon Lamé's formulas as modified for lateral contraction according to the principles established by Clavarino; these formulas are also the basis of the ordnance formulas employed by the United States Army and Navy. For economy in weight, the stresses in the metal of a gun, at the instant of explosion, approach closely to the elastic limit. It is evident, then, that the use of these formulas for such work makes their accuracy, for shrinkage fits in gun-steel, unquestionable. So far as is known, their fundamental principles are general, and they can be employed with equal accuracy for similar fits in cast iron. It has been customary to assume that they could be applied also for the determination of the stresses in the metals of forced fits. This assumption is, in the author's opinion, unwarranted, so far, at least, as cast-iron outer members with large forcing allowances are concerned. There seems to be considerable evidence in support of this contention.

The basic principle of shrinkage and forced fits is the same, but there is a radical difference between the methods by which this principle is applied in the two cases. In the shrinkage fit, the outer member, owing to its expansion, slips freely into place, giving, in cooling, clean, smooth and accurately fitted surfaces. In forced fits, on the contrary, there may be, in forcing, more or less abrasion, and, further, if the allowances be large, there may be an axial flow of the metal of the hub in advance of the entering shaft. It should be noted that, in forcing allowances, we are dealing with a layer of metal whose thickness is, in general, but 0.001 inch per inch of diameter, so that the total volume of the metal thus displaced would be very small, while its removal with that lost by abrasion, would reduce materially the amount of the effective allowances, and, in consequence, the stresses and "grip" of the fit. Taking the elastic limit in tension of cast iron as 6000 to 7000 pounds and that of steel as 50,000 pounds, and considering the corresponding values of E, the former will endure, without permanent set, less than one-fourth the deformation of the latter, yet the forcing allowances of the two metals are often made the same, and, further, with the same metals and dimensions, some builders make the allowances for forcing considerably greater than those for shrinkage fits. In such cases, there must be either permanent set in the cast-iron hub, or the effective allowances must be materially lessened by abrasion, displacement, or both.

In Professor Wilmore's tests, the average resistance of the shrinkage fit to slip was, for an axial pull, 3.66 times greater than that of the forced fit, and, in rotation or torsion, 3.2 times greater. In each comparative test, the dimensions and allowances were the same for both. These results imply either permanent set or considerable abrasion or displacement of the metal of the forced fit. While these experiments were made on a small scale, they agree with the general estimate of the comparative strength of forced fits.

Table VI represents the practice of one of the largest builders of engines and other machinery in the United States, in forcing cast-iron cranks and wheel-hubs on steel shafts. The allowance for a crank is greater than that for a wheel-hub, and, with both, the allowance per inch of diameter decreases with increasing diameter. Take the unit-allowance for a 12-inch wheel-hub which is 0.001 inch. Assume the ratio of the external diameter of the hub to that of the shaft (solid) as 1.8, which gives a hub-thickness of 4.8 inches. In Equation (22), $S = 0.001$, and, from Table III, $C = 0.311$, then the true tensile stress T_2 at the bore of the hub is about 13,000 pounds, or twice the elastic limit of cast iron. Again, we have here indications of permanent set, excessive abrasion, or very considerable displacement of the metal, so that the effective allowances cannot be those initially given.

Finally, the following formulas given by Mr. Stanley H. Moore may be cited. In these formulas, d denotes the total allowance, and D is the diameter of the shaft, in inches.

Shrinkage fit $$d = \frac{\frac{17}{16}D + 0.5}{1000}$$

Forced fit $$d = \frac{2D + 0.5}{1000}$$

These formulas show again a much greater allowance for forcing than for shrinkage.

Forced fits may be made by levers, screw-jacks, or hydraulic pressure, the latter being the most common. In the drive-fit, the pin is sent home by sledges; the allowances are usually about half that of a forced fit. With these various methods and the many purposes for which forced fits can be used, it is natural that the custom as to the amount of the allowances should differ, as it does, very widely, so that the practice cited here is not universal. The purpose of this discussion has been simply to point out that shrinkage formulas will not give with accuracy the stresses in a cast-iron hub, when the allowances are very large, or in any forced fit with undue allowances. Such a fit differs essentially from the shrinkage joint for which the formulas were constructed.

Cotterill says in his "Applied Mechanics," London, 1895, page 412: "When the limit of elasticity is overpassed, the formula (Lamé's) fails, and the distribution of stress becomes different. If the pressure be imagined gradually to increase until the innermost layer of the cylinder begins to stretch beyond the limit, more of the pressure is transmitted into the interior of the cylinder, so that the stress becomes partially equalized. If the pressure increases still further, the tension

of the innermost layer is little altered, and, in soft materials, longitudinal flow of the metal commences under the direct action of the fluid pressure. The internal diameter of the cylinder then increases perceptibly and permanently. This is known to happen in the cylinders employed in the manufacture of lead piping, which are exposed to the severe pressure necessary to produce flow in the lead. The cylinder is not weakened but strengthened, having adapted itself to sustain the pressure. Cast-iron hydraulic press cylinders are often worked at the great pressure of 3 tons per square inch, a fact which might be explained by a similar equalization."

TABLE VII. EXAMPLES OF TYPICAL FITS, FROM PRACTICE

Diameter of Pin or Shaft, Inches	Total Allowance, Inches		Metals
	Shrinkage	Forcing	
1.8798	.....	0.0031	Shaft, steel. Hub, cast iron
4.2505	.....	0.0103	Shaft, steel. Hub, cast iron
8.9	.....	0.0152	Shaft, steel. Hub, cast iron
4 to 5	0 0045	0.0090	Cast iron crank
7.5 to 9	0.0027	0.0055	Cast iron crank
16 to 18	0.0015	0.0030	Cast iron crank
4	.....	0.0120	Crank, cast iron. Shaft, steel
8	.....	0.0120	Crank, cast iron. Shaft, steel
16	.....	0.0144	Crank, cast iron. Shaft, steel
1 to 2	0.0090	0.0010	
4 to 6	0.0156	.....	
5 to 7	.....	0.0050	
9 to 12	0.0313	.....	
10 to 12	.....	0.0100	
5	.....	0.0050	Shaft, steel. Crank, cast steel
5	.....	0.0100	Shaft, steel. Crank, cast iron
11	0.0070	) (	Cast iron counter-balance
13	0.0060	) (	plates on steel crank-disks

Forcing Pressure

When the fit is cylindrical, the forcing pressure varies as the rate of advance of the inner member, reaching a maximum in continuous forcing when the pin or shaft is at the inner end of the hole. At this point, the pressure is theoretically equal to Q, the resistance to slip, as given in Equation (21), the coefficient of friction f being probably between 0.12 and 0.2, although it may vary widely. Tables VI and VIII give values of the forcing pressure, as found in practice. The assumption above, that the maximum forcing pressure is equal to the resistance to slip, is true only if that pressure is expended wholly in overcoming the obstruction to motion produced by the resistance of the outer member to expansion, and of the inner to compression. If there is abrasion of the surfaces, or axial displacement of the metal in advance of the entering member, the assumption is not fully justified.

Applications in Practice

Railway Work. In railway work, steel tires are shrunk on the cast-iron wheel-centers of driving wheels. The fit is cylindrical; a common, although not universal, shrinkage-allowance is 0.001 inch per inch of diameter of the finished wheel. Forced fits are used for securing wheels to axles and crank-pins to driving wheels. In wheel-fits, the joint is cylindrical; the pressure is usually 9 to 10 tons per inch of diameter of fit. In removing a wheel after long service, the total pressure may reach 150 tons.

Stationary Engines. Shrinkage and forced fits—the latter more frequently—are used for crank-pins, cranks, wheel-hubs, and minor parts. With different builders, the amount of the unit-allowance has a wide range, owing to differences in the thickness of hubs, the forcing pressure employed, etc. General practice seems to favor a smaller allowance for shrinkage than for forcing, and, with increasing diameter, a decreasing unit-allowance. The latter is usually greater for cast iron than for steel. Table VII, which gives the data for typical fits from different builders, shows the variation in practice. In Table VIII will be found complete data for forced fits from 2 to 9 inches in diameter.

Marine Engines. In marine work, built-up crank-shafts are assembled and the casings of propeller shafts are secured by shrinkage fits. Forced fits have been employed for crank-shafts and are frequently used for smaller parts. In building up a steel shaft, the allowance is usually 0.001 inch per inch of diameter; the cranks and crank-pins are keyed, in addition to the shrinking. The crank-webs are heated by gas in a sheet-iron furnace until the expansion is sufficient for a free fit; they are then removed, the pin is pushed home and keyed, and the webs and pin are cooled with water. The webs are then set with the bores for the shaft vertical, and one is heated as before until sufficiently expanded, when the section of the shaft is lowered into place and keyed; the same method is followed with the other section of the shaft.

Shaft casings are of bronze, usually from ⅝ inch to 1 inch thick at various sections of the shaft. In one case there were two such sections of casing, each 8 feet long and 20½ inches internal diameter. The shrinkage-allowance, total, was 0.013 inch, or 0.000634 inch per inch of diameter. Each section was set vertical and heated internally by gas. When expanded, it was slipped in place on the shaft, and the inner end was held firmly and cooled with water until it gripped the shaft.

Gun Construction. When a charge is exploded in the powder-chamber, the principal stress to which a gun is subjected is that due to the radial pressure of the gases which tends to burst it on an axial plane. This stress produces tangential (circumferential) tension in the tube, jacket, and hoops, and, in addition, there is a direct longitudinal stress in the layer of the tube in which the breech-plug houses. There also exists at all times, except during explosion, a radial compressive stress on the inner cylinders of the system, due to the shrinkage pressures of those outside of them. At the breech, there may be three or four of these superposed cylinders—the tube, the jacket, and one or two sets of concentric hoops. The radial pressure of the gases would produce in the tube, if the latter were unsupported, a circumferential tensile stress which would exceed the elastic limit of the metal. To counteract this, the jacket and hoops are shrunk on, each of these cylinders putting the one which it encases under compression, and the aggregate of these radial pressures being transmitted to the tube. The actual tensile stress in the latter, during the burning of the powder, is then the difference between the tensile stress developed by the gases and the compressive stress due to the jacket and hoops—a remainder which is less than, but usually fairly close to, the elastic limit of the metal.

For maximum economy of material, the relations of the

TABLE VIII. DATA FOR FORCED FITS, FROM PRACTICE

Mean Diameter of Pin, Inches	Length of Fit, Inches	Mean Diameter of Hole, Inches	Total Allowance	Allowance per Inch of Diameter	Area of Fitted Surface, Square Inches	Volume within Fitted Surface, Cubic Inches	Pressure to Enter Pin, Tons	Pressure at Mid-Position, Tons	Maximum Pressure, Tons
1.8798	6.125	1.8767	0.0031	00.0170	36.0	16.7	2	10	20
1.8819	6.125	1.8770	0.0042	0.00220	36.0	16.7	2	15	23
1.8774	4.375	1.8764	0.0010	0.00052	24.4	13.7	0.5	1	1
2.7455	4.500	2.7387	0.0068	0.00247	38.7	26.5	3	12	25
2.7465	4.500	2.7437	0.0028	0.00100	38.7	26.5	5	12	23
3.2610	5.000	3.2542	0.0068	0.00210	51.0	41.5	5	20	45
3.2625	5.000	3.2555	0.0070	0.00200	51.0	41.5	5	15	30
3.2670	5.000	3.2610	0.0060	0.00180	51.0	41.5	5	15	20
4.2505	6.000	4.2402	0.0103	0.00240	79.8	85.1	5	22	44
4.2388	6.625	4.2478	0.0091	0.00210	78.1	93.4	12	30	60
4.2303	6.500	4.2224	0.0079	0.00190	95.8	91.0	10	60	125
5.9343	4.062	5.9216	0.0127	0.00220	75.7	112.2	6	16	25
5.9381	4.000	5.9252	0.0129	0.00220	74.4	110.4	3	18	35
5.9294	4.125	5.9194	0.0100	0.00170	76.7	113.8	5	15	25
6.8829	5.125	6.8697	0.0132	0.00200	110.7	190.1	8	20	42
6.8890	5.000	6.8785	0.0105	0.00150	108.0	185.9	5	22	45
6.8692	4.875	6.8550	0.0142	0.00210	104.8	180.4	5	35	65
7.8884	5.500	7.8730	0.0154	0.00200	135.9	267.3	5	32	64
7.8715	6.500	7 8575	0.0140	0 00180	160.5	315.9	5	25	50
7.8620	5.625	7.8460	0 0160	0.00200	138.2	272 8	8	40	80
8.9240	6.125	8.9050	0.0190	0.00210	170.8	378.9	20	45	68
8.9000	6.750	8.8848	0.0152	0.00170	188.4	419.9	5	47	96
8.8780	6.500	8.8669	0.0112	0.00130	180.7	401.0	10	45	92

thicknesses and shrinkage-allowances should be such that the stresses at all points in the walls of the built-up gun will be, during explosion, not only approximately equal but also the greatest permissible, with due regard to the elastic limit and the factor of safety. The outer layers of the metal are, therefore, in a state of initial tension, the inner under initial compression, and during explosion all are in tension. The principles involved are those which have been treated herein for shrinkage fits, with the added requirement that the superposed cylinders, during explosion and the subsequent release from pressure, must expand and contract together, so that each cylinder must have a definite shrinkage-allowance with regard to all the others of the system.

* * *

RULES FOR THREADING SQUARE THREAD TAPS

One of the New England tap makers, in cutting the threads in square-threaded taps, makes them according to the rules below: The width of the groove between two threads is made equal to one-half of the pitch of the thread less 0.004 inch. The width of the thread itself is made equal to one-half of the pitch plus 0.004 inch. The depth of the thread is made equal to 0.45 times the pitch plus 0.0025 inch. This latter rule provides for a thread which for all the ordinarily used pitches for square-threaded taps has a depth less than the generally accepted standard depth, this latter depth being equal to one-half the pitch. The object of this "shallow" thread is to insure that if the hole to be threaded by the tap is not bored out so as to provide clearance at the bottom of the thread —something that ought to be provided, but which is not always done—the tap will cut its own clearance. This method of obtaining the clearance is not, perhaps, a very desirable one, as it is much simpler and better to drill the hole to be tapped the required amount over-size. It is of course assumed that this is done in the majority of cases, but when neglected, the dimensions here given for the depth of the thread in the tap insure that a reasonable amount of clearance will always be provided.

* * *

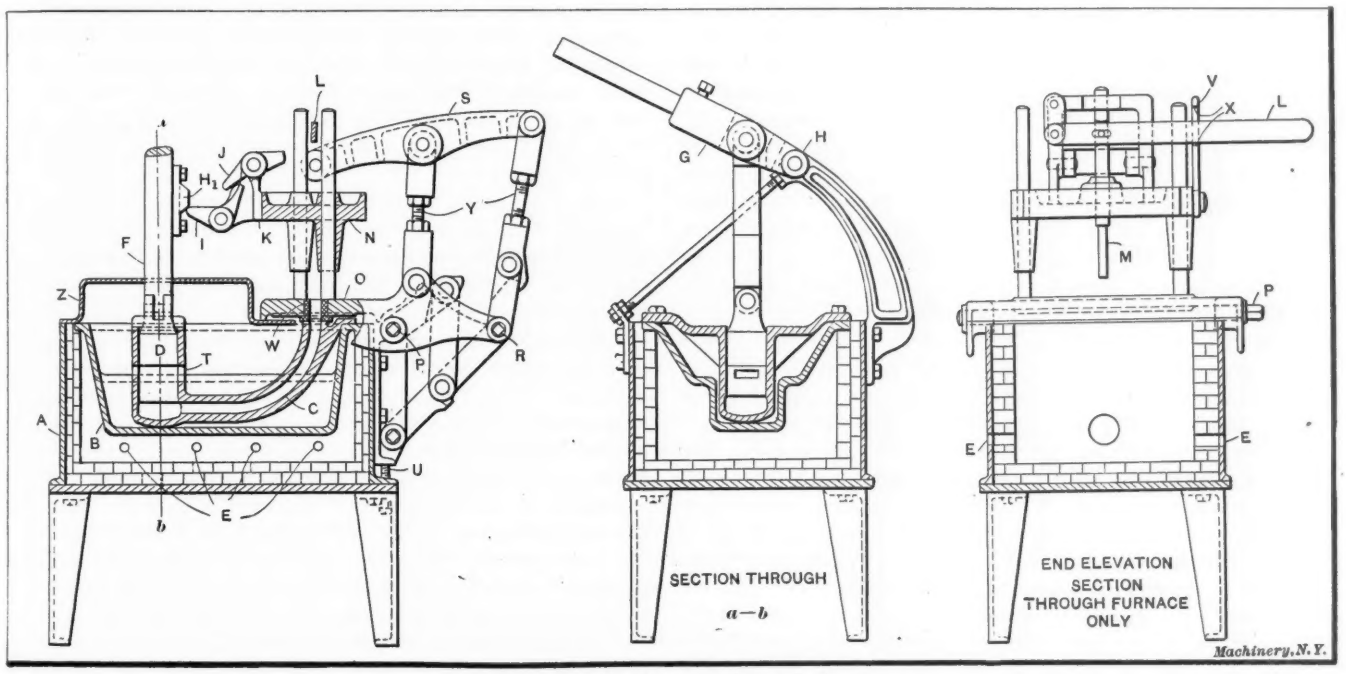
An indication of the advance of China in engineering matters is afforded by the establishment in Pekin of a school for training railway officials and engineers. The equipment provides for 600 students, the present number being 350. The full course is three years, the students varying in age between 18 and 25. Among the instructors are one American, one Englishman, two Frenchmen and two Germans, the remaining twenty-four being Chinese who have been educated abroad.

DIE-CASTING AND DIE-CASTING MACHINES*

By A. W. CHRISTIANSON†

A. W. Christianson‡

The subject of die-casting is one about which comparatively little is known by the majority of mechanics. In the following article a simple method for making die-castings is explained, and one of the best machines for casting white metal, or for making "pressure castings," as they are often called, is described. The accompanying illustration shows cross-sectional elevations of the machine, which so far as the writer knows is the latest design of die-casting machine in practical use. No skill is required to operate it; an ordinary laborer can learn how to do it in a very satisfactory way in a short time. When the dies are small and there are only two or three levers to be handled, one man can operate the machine advantageously. But when larger dies are used and a number of levers must be handled, it is more economical to employ two men at the machine.



Die-casting Machine of the Latest Design

It is important, however, that only one man control the injection of the metal into the dies. This is a very essential point, because two men cannot produce exactly the same results for every pouring. Uniformity in the control of the injection of the metal is one of the basic points in white metal die-casting.

In designing a die-casting machine, it is necessary to so arrange it that the metal will be handled as little as possible, as otherwise part of the metal would oxidize and be wasted. The molten metal should be covered so that the air will not strike it more than is absolutely necessary. In the machine

* See MACHINERY, January and February, 1911: "Die-casting."

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shown in the accompanying illustration, the metal comes into contact with the air only at the nozzle, where it is injected into the die. It may be argued that this would have a detrimental effect on the casting, but experience has shown that it does not; the reason for this is that the surface which comes in contact with the air is so small in comparison to the amount of metal that is pressed out each time, that the few seconds during which the air comes into contact with the surface is not enough to have any serious effect. This is particularly true in the case of large castings. In the case of small castings the metal is poured so much oftener that the surface of the metal at the nozzle is not in contact with the air long enough to injure the casting.

The design of the die-casting machine is, briefly, as follows: In the accompanying illustration *A* is a gas furnace made by the American Gas Furnace Co., 24 John St., New York, this furnace being one of the standard sizes. At *E* are shown the gas burners, four being placed on each side of the furnace. The metal is melted in the pot *B*, and the gas burners can be so controlled that the heat can be directed toward any part of the melting pot. This pot is made of cast iron, and it can be replaced by one of the standard sizes made by the American Gas Furnace Co., at very little cost, when burnt out. The life of the pot depends upon the metal used for making the die-castings. If the metal requires a high degree of heat for melting, the receptacle naturally will not last so long as when less heat is required for melting.

At *C* is shown the part forming the nozzle which is connected to a cylinder in which the metal is compressed by means of the plunger *D*. When the plunger descends, the metal is pressed or pushed out through the nozzle *C*, which is tube-shaped as shown in the illustration. At *F* is shown a connecting-rod which is operated by means of the handle *G* having its fulcrum at *H*. A dog or trip H_1, fastened to the connecting-rod *F*, operates the lever *I* which, in turn, moves the lever *J*, both of these levers being mounted on bracket *K*. The lever *J*, in turn, operates the handle *L*. To the handle *L* is attached a rod *M*, called a "sprue cutter." The part *V* acts as a stop for the motion of lever *L*, this motion being limited between the points *X*. The stop *V* swings out of the way for lever *L*, when the core is being pushed out of the casting.

The dies are fastened between the plates *N* and *O*. The plate *O* is hinged at *P*, and the shaft passing through the lever at *P* is squared on the end as shown, so that a handle may be put on the shaft. In this way plate *O* can be swung away from the nozzle, thus allowing the die to swing away from the furnace through an angle of about 45 degrees. This uncovers nozzle *C*, permitting the pushing out of the so-called "core," which is formed at every pouring. It is advisable to have the core as small as possible, but, of course, the size of the core depends very largely on the size of the casting. When the die-plates are swung away from the nozzle, the operator chills the core by means of compressed air blown through a rubber tube, and when this is done the core is forced out by a forward push of the handle *L*, which at that moment operates the sprue cutter *M*. This action releases the core which is slightly tapered in order that it may be easily removed.

The next operation is to separate the two plates *O* and *N*, thus opening the die, one-half of which is held on the plate *N* and the other on the plate *O*. The die-plates *N* and *O* are separated by operating a handle placed on shaft *R*, which through a set of connecting links and the arm *S* separates the two plates. At *Y* adjustment is provided for setting the two plates properly for any size of die. The top of the furnace is covered by a sheet-iron lid *Z*, lined with asbestos. This cover is left on all the time when the heat is on or when the metal is melted, so as to prevent the latter from coming into contact with the air.

At *T* is a slot in the pressure cylinder through which the molten metal runs into the cylinder before being pressed into the die. The screw *U* serves the purpose of adjusting the nozzle, so as to get it perfectly tight. This is an important factor, as is also the cleaning of the nozzle, which should be done after every pouring, by the operator. This takes but a moment's time and makes it possible to obtain good results. Many times the neglect of this precaution has made it difficult to obtain good castings.

When the die is open ready to eject the casting, the operator takes the air hose and chills off the casting for a moment. Then he grasps the handle connected to the ejecting pins in the die, and puts one hand under the edge of the die, when a push of the handle makes the piece or pieces fall into the hand of the operator. The air hose is again used for cleaning the die. The reason for this is that after every pouring there is, due to the pressure, a small fin formed on the face of the die, and this must be removed before casting another piece. Blowing the air over the face of the die removes it easily. After the die is cleaned and again closed, plate *O* is closed down over the nozzle and everything is ready for the next pouring. All the operations described require but a part of a minute, especially when the machine and dies are small and light. When a larger machine and larger dies are used, the work cannot be done so rapidly, but will be in proportion to the size and design of the pieces to be cast.

Many experiments have been made to obtain a strong and durable metal for die-castings. When making small parts for machines which require high tensile strength, great care must be exercised to obtain a strong metal and one that flows easily, because when the metal flows easily it is possible to obtain a solid casting. The mixing of the metal must be done in a careful manner, because white metal is very treacherous, and carelessness at this time makes it difficult to obtain good castings. The metal must be carefully handled, and care taken to see that it is not too hot when casting. If it is too hot, the operator will have difficulty in obtaining good sound castings.

The dies should be heated slightly before beginning the casting. This is done by closing the die and also closing the plate *O* lightly against the nozzle while the metal is melting. The die will then be of the right temperature for starting the work when the metal is melted. Care should also be taken to keep an even heat in the furnace, so that the temperature of the metal is the proper one for obtaining solid castings. This can be done only by a man experienced in white-metal casting. The metal should not be put into the pot in "pigs," as this chills the melted metal in the pot and causes difficulties. Instead a small furnace should be used alongside of the machine for melting the metal. This melting can be done at a slow heat which is, in itself, a good thing for white metal. When more than one man works the machine it is difficult to obtain castings without blow-holes. A casting may look good on the outside, and when broken may show such defects as to make it useless for the purposes for which it is intended.

* * *

CONSTANT ATTENTION REQUIRED FOR AUTOMATIC MACHINES

Constant attention is required by most automatic machinery to supply stock, correct defects of feed, flow of lubricant, clogging of parts, etc. Some time ago a concern having a department equipped with automatic machines which was kept tuned up to a high efficiency, determined to make a test to find out to what extent the machines were actually automatic. The operators were instructed to leave their machines running during the noon hour with the hoppers supplied with blanks, and were promised full pay for the extra production. One attendant was left in charge of the running machines with instructions to do absolutely nothing except to shut down machines that clogged or went wrong in any particular. He did as told, keeping close watch and throwing the shifters of the machines as soon as they balked. The result of the test, which continued for several consecutive noon hours, was that practically every machine was stopped before 1 o'clock. The operators had the entire forenoon to get their machines in good working condition, but nevertheless automatic performance for one full hour was beyond their capability.

* * *

Some people have too much wish-bone and not enough backbone to get far in the world.

MILLING CUTTERS AND THEIR EFFICIENCY*

The amount of metal which a machine tool can remove in a given time is limited by the strains caused by the cut, and while it is possible to increase the driving power indefinitely, and almost any amount of metal can be put into machine elements to give them rigidity, there are certain classes of machines where practical considerations limit such increase of power and strength. This is especially true in machines where the main elements must be adjusted frequently; the knee-and-column type of milling machine owes its success in a large measure to the ease and rapidity with which it can be manipulated. In order to increase the capacity of this type of milling machine, it becomes necessary to reduce the strains set up by the cut. To accomplish this result, there are only two elements which can be modified; these are the hardness of the metal to be cut and the cutting qualities of the milling cutter. The latter is the only controllable avenue for improvement.

This article is the outcome of an extended series of tests, carried on at the works of the Cincinnati Milling Machine Co.,

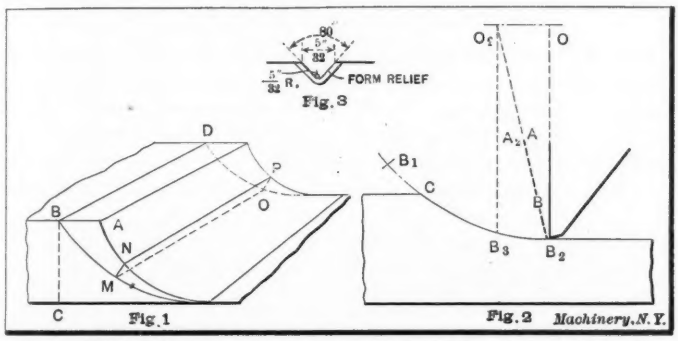


Fig. 1. Metal Chip assumed to be produced by Milling Cutter without Distortion. Fig. 2. Diagram to illustrate Action of Milling Cutter. Fig. 3. Detail View of Chip Breaker

on spiral mills, end mills, side mills, slitting saws, face mills, and a new type of mill which, for lack of a better name, will be called a "helical mill."

The ordinary milling cutter does not give a true cutting action, for by this term is meant the driving of a wedge-shaped tool between the work and the chip. In a milling cutter the tooth compresses the metal until it produces a strain great enough to cause a plane of cleavage at some angle with the direction of the cutter; it then begins to compress a new piece, push it off, and so on. This at least seems to be the action of the cutter, judging from the form of the chips. If no compression occurred, the milling chip would appear as in Fig. 1, which is very much exaggerated for illus-

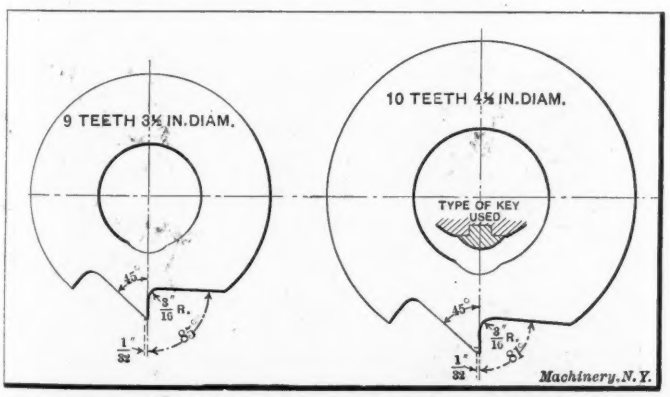


Fig. 4. Form of Spiral Milling Cutters now used by the Cincinnati Milling Machine Co., showing Wide Spacing, Large Arbor, and Form of Key Recommended

trative purposes. *AB* is the feed per tooth, *BC* depth of cut, and *BD* the width of cut. The normal section *MNOP* is a measure of the amount of work done by the cutter when passing the point *M*.

Fig. 2 shows the action of a milling cutter with center *O*, when the cutter is rotating and the work is being fed simultaneously. The tooth *AB* sweeps the path *BC*; when the point *B* has reached the position B_1 a new tooth begins to cut, but by this time *O* has advanced to position O_2 and the new tooth A_2B_2 is not yet in a vertical position when the point B_2 touches the work. When the cutter revolves, this point B_2 must penetrate into the work and compress the metal, resulting in the springing of the arbor. When this spring has assumed certain proportions, the tooth begins to remove a chip; this may be assumed to be at position B_3, the tooth simply gliding over the work from B_2 to B_3. It is believed that this, perhaps more than any other action of the cutter,

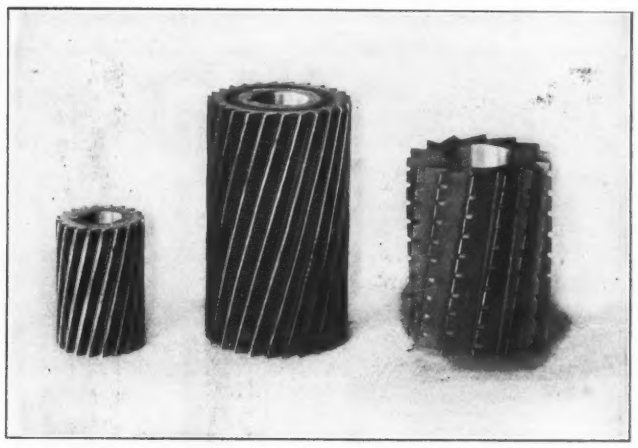


Fig. 5. Comparison of Old- and New-style Spiral Mills

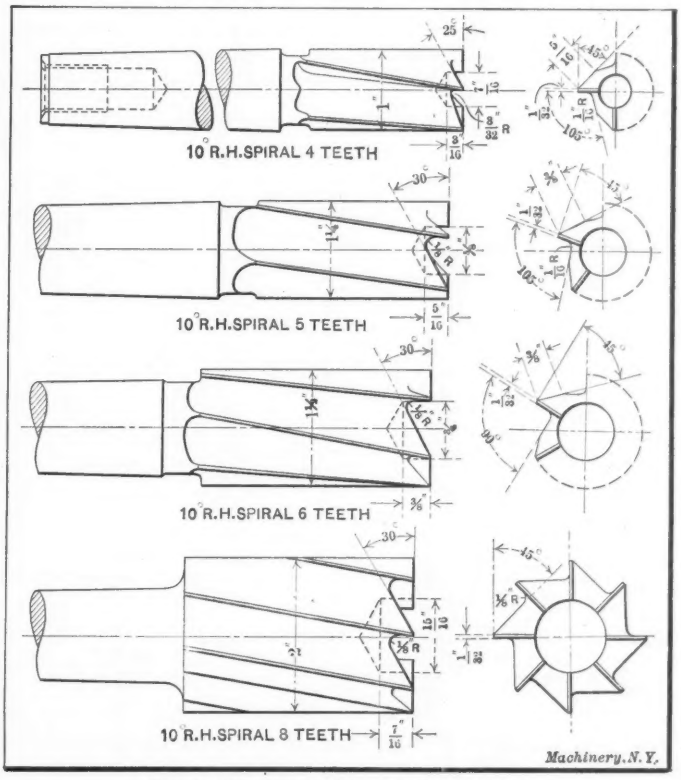


Fig. 6. New Type of Taper-shank End Mills

causes its dulling; this peculiar action of the milling cutter is inherent in its construction and cannot be avoided.

Another feature tending to limit the ability of a milling cutter to remove metal is the proportion between the chip to be removed and the amount of space between two adjoining teeth. This was emphasized to the writer when a very powerful machine stalled on a comparatively light cut; upon examination it was found that the amount of metal removed per tooth was sufficient to fill the chip space completely, and from that moment the action was like trying to push a solid bar of steel through a piece of cast iron.

These conditions have led to the gradual evolution of spiral milling cutters. In Fig. 4 are shown the spacings adopted for the new style of wide space milling cutters, now used by the Cincinnati Milling Machine Co., while Fig. 5 gives a graphic comparison between the two. Experiments made with cutters of this type show that the amount of metal

* Abstract of paper presented before the Spring meeting of the American Society of Mechanical Engineers, by Mr. A. L. DeLeeuw, Mechanical Engineer, Cincinnati Milling Machine Co., Cincinnati, O.

capable of being removed for the same expenditure of power and on the same machines, is very materially increased. In connection with these cutters, attention should be drawn to the fact that present practice calls for arbors too small; in the cutters shown, the 3½-inch is made with 1½- and 1¾-inch arbors, and the 4½-inch with 1¾- and 2-inch arbors.

Another important feature determined from experiment was that, for roughing on ordinary work in the shop, a cutter

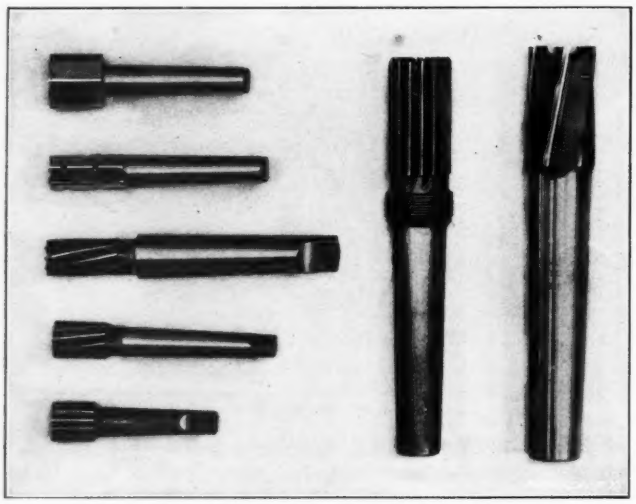


Fig. 7. Comparison of Old- and New-style End Mills

with the wider-spaced teeth would remain sharp for a longer period, notwithstanding increased feeds. A further advantage is that only about one-half the time required for sharpening what is now considered a standard cutter, is required owing to the number of teeth being about half. This same feature

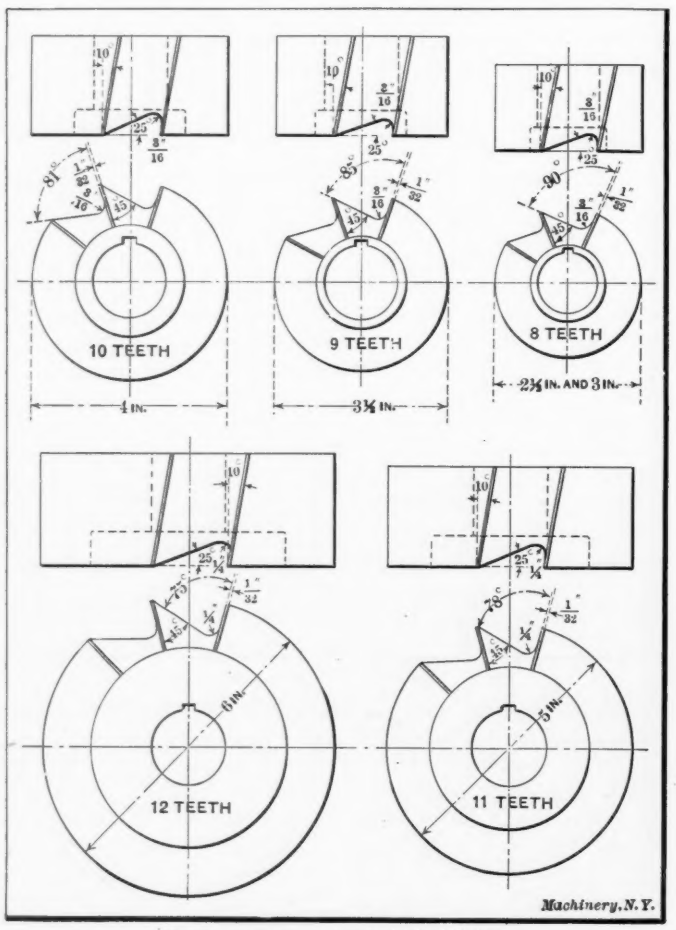


Fig. 8. New Type of Spiral Shell Cutters

makes it possible to sharpen the cutter more frequently owing to the body of the tooth.

These wide-spaced cutters were originally intended for roughing-out operations only, but the very satisfactory finish obtained when roughing led to their adoption for finishing purposes as well. In this connection it might be mentioned that for finishing alone it is generally believed that a milling cutter should be used without chip breakers, as the latter tend to scratch the surface. To overcome this trouble, chip breakers were made, as shown in Figs. 3 and 5, with clearance at both corners; this prevents the tearing up of metal, with the result that a cutter with these breakers produces as good a finish as one without them. One of the great advantages of this form of chip breaker is that one gang can be used for both roughing and finishing.

It is a common belief that a better finish is obtainable with teeth closely spaced, but experience with the wide-spaced cutter shows that there is no ground for this assumption, for the marks on the work are not due to the indentation left by the successive teeth, but are revolution marks which it is practically impossible to eliminate. These are due to the cutter not being concentric, the arbor being slightly out of

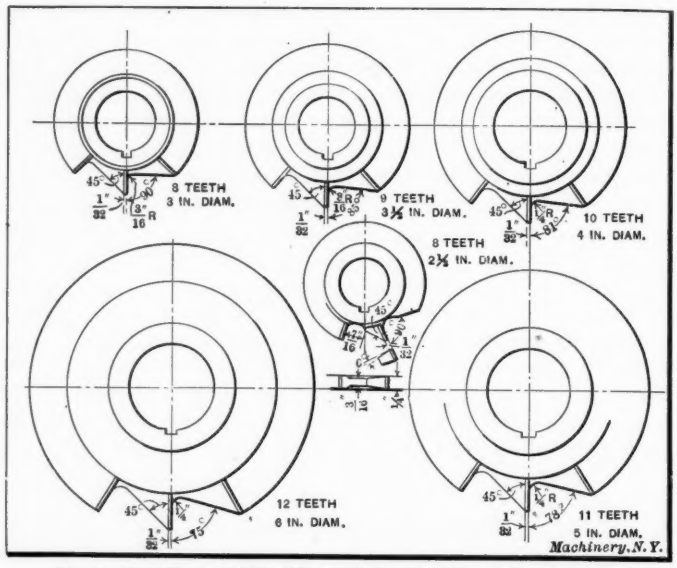


Fig. 9. New Type of Side Mills with Detail of Tooth Construction

true, or one of many trifling errors which, accumulated, make the shallow groove noticeable. This was proved by putting cutters of each type on the same arbor and taking cuts, when it was found that the marks corresponded. Following this, on each of the cutters all but one tooth were ground away so as not to cut, and the surface produced by these one-tooth cutters presented the same appearance as those just previously obtained.

Fig. 6 shows the end mills now considered standard by the company, and Fig. 7 shows them in comparison with the old style. Similarly, Fig. 8 shows the new type of spiral shell cutters, and Fig. 9 the new type of side mills, the center cutter of this group showing the general characteristics of the tooth.

Face mills have undergone a gradual evolution, for while

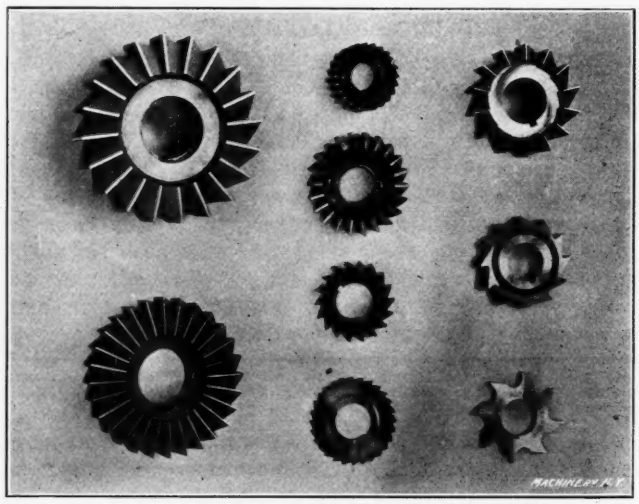


Fig. 10. Comparison of Side Mills and Slotting Mills

in the old style the blades were spaced about 1 inch apart and set radially, they now have a 2-inch spacing and are set at an angle of about 15 degrees with a radial line, and are backed by a backing-ring with a set-screw for each blade.

Fig. 11 shows the previously-mentioned new type of helical

cutter; these cutters consist of a cylindrical body with two or three screw threads wound around them, the threads being of the section indicated in the engraving. The helix is wound around the body at an angle of 69 degrees with the axis, the other details being shown in the illustration. Their most distinguishing feature is that they push the chip off in the

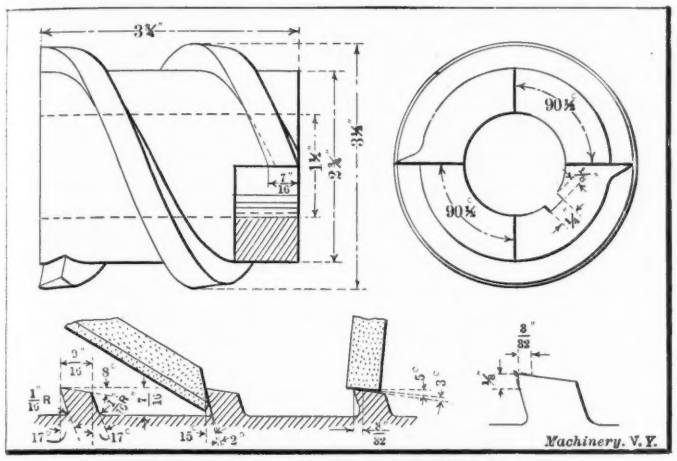


Fig. 11. Details of New Type of Helical Cutter

direction of the axis of the cutter, at right angles to the feed. The power consumption is extremely low, but does not show up so favorably for cast iron. For a roughing cut in steel, only about one-third the power of the old-style spiral mill is required. In addition, the cutter does not make revolution marks, but instead makes tooth marks permitting of a coarser

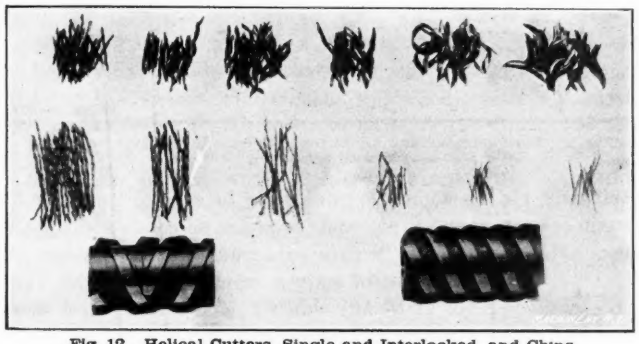


Fig. 12. Helical Cutters, Single and Interlocked, and Chips produced by them

feed. Still another feature of this cutter is the entire absence of spring in the arbor when cutting steel; it is possible to take a finishing cut over a piece of steel, and return the work under the revolving cutter without producing a mark.

For roughing purposes on account of the excessive end pressure on the spindle, the interlocking cutter shown in Fig. 12 was produced. However, it was found that this end pressure, though perceptible, was not a disturbing element. The same illustration shows the kind of chips produced by this type of cutter. While it was first believed that these cutters would work more advantageously at high speed, it has been found that the best results are produced when they are operated at the same speed as the ordinary spiral mill.

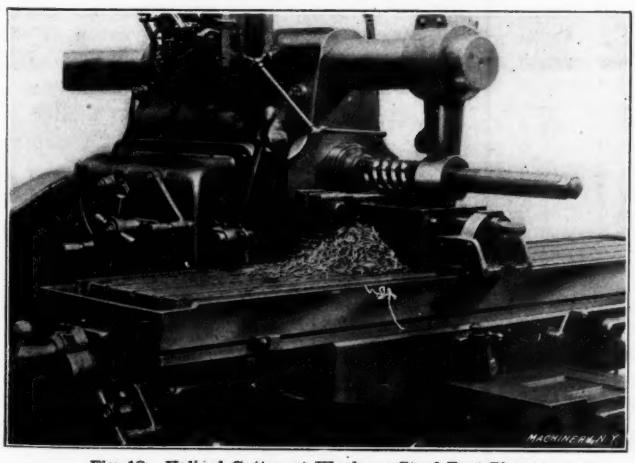


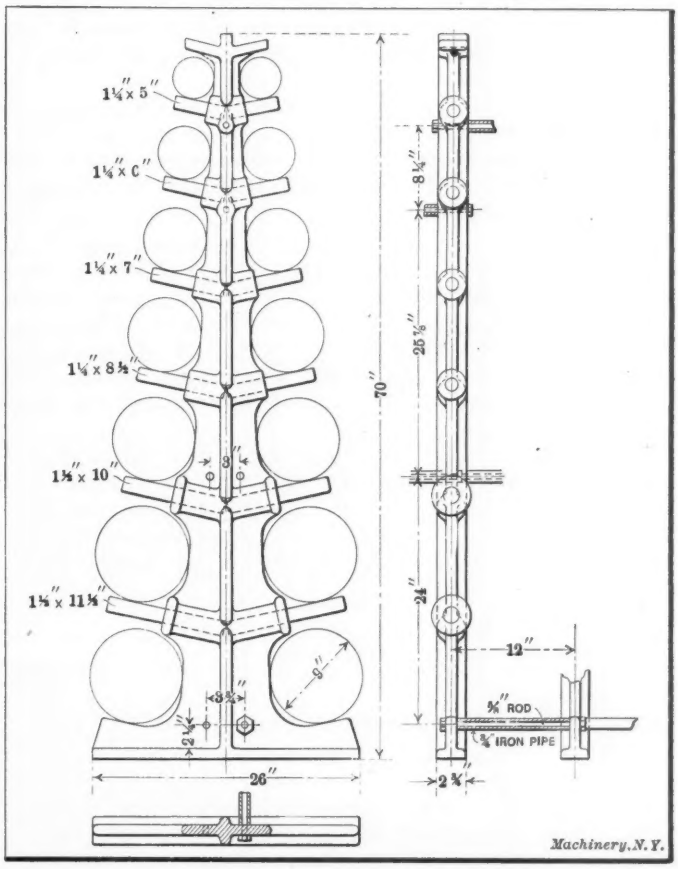
Fig. 13. Helical Cutter at Work on Steel Test Pieces

The writer believes that the remarkably low power consumption is due to what might be called "virtual rake" which is an angle depending upon the angle of rake and on the angle the thread or tooth makes with the axis. This virtual rake becomes a small angle when the actual rake is small. This may explain why the saving in power consumption is not so pronounced when cutting cast iron. It is believed that this saving in power would be equally as great as with steel if the same virtual rake could be obtained, and this supposition was proved by a few tests made on cast iron with a helical cutter ground for steel.

* * *

STOCK RACK FOR HEAVY BAR STOCK

The storing of heavy bar stock of from four inches in diameter upward is a rather difficult problem. Ordinarily, heavy bars of this kind are put on the floor in the stock-room, thus occupying a considerable floor space and, as a rule, being difficult to get at when required. The accompanying illustration shows a stock rack for heavy bar stock used at the



Stock Rack for Large Diameter Bar Stock

plant of the Union Twist Drill Co. of Athol, Mass., which presents a satisfactory solution to this problem.

As shown, the rack consists of very heavy cast-iron stands or uprights, having machine steel pins or plugs cast in place, these pins being 1½ inch in diameter for the lower spaces and 1¼ inch in diameter for the higher spaces, where the smaller bars are kept. These uprights are placed at a distance of one foot apart, as shown to the right in the illustration, the whole length of the rack being 18 feet. The stands are held together longitudinally by means of ⅝-inch rods, over which are placed ¾-inch iron pipes acting as spacers. It will be seen that every other hole provided in the stands has a bolt connecting with the stand to the left, while every other hole has a bolt connecting with the stand to the right, so as to firmly connect the whole system of uprights. Over this arrangement of stock racks a traveling crane is used, so that any bar can be easily and conveniently removed from its location in the stock rack and be brought to the cutting-off machines. By casting the machine steel supports in place, it was possible to make these racks with practically no machine work, except that of drilling the holes for the connecting rods between the stand. The largest bar provided for by the stock rack shown is 9 inches in diameter. This is a trifle larger than the largest regular diameter bar manufactured.

THE AIR-LIFT PUMP

By HARRY L. GLAZE*

The air-lift is in general use in pumping and metallurgical plants, but is little known to those engaged in other mechanical pursuits. A better knowledge of the air-lift among mechanics and mechanical engineers would result in the development of many more uses for this valuable principle.

The action of the air-lift is simple and easily understood, but many theories have been advanced by various authorities to explain the phenomenon; the explanation following is perhaps the one most widely accepted. In order to consider the principles involved it will be necessary to refer to Fig. 1, which shows the air-lift as ordinarily applied to pumping from wells. Here *A* shows a pipe which serves as the discharge pipe to carry the water out of the well *B*, *C* is an air pipe which carries the air from the compressor and introduces it into the open end of the discharge pipe, which is usually made with a slight bell at the bottom; this air pipe is bent up so as to pass a short distance into the discharge pipe. It will be noticed that the discharge pipe is submerged in the water, and upon the amount of this submergence depends the efficiency of the pump.

The action is as follows: Air is introduced into the air pipe *C* under pressure sufficient to overcome the static head of the water from the end of the pipe to the surface of the water; this head is called the "submergence." The distance from the surface of the water to the highest point that the water is lifted is called the "lift." When the air issues into the water contained in the discharge pipe it breaks up into small bubbles which form, by virtue of the violent action, what is virtually an emulsion of air and water. This emulsion is lighter than water and of course it is forced up into the discharge pipe by the weight of the water outside and will be made to issue from the top of the discharge pipe with considerable violence.

The results obtained are improved but very little by the various fancy and expensive devices on the market which are made for attaching to the lower end of the discharge pipe. The best results are of course obtained when the submergence exceeds the lift; in fact, the efficiency of the system varies directly as the ratio of lift to submergence. In deep-well pumping, the conditions are seldom ideal for a high efficiency, but when the simplicity of the whole arrangement is taken into consideration one can readily appreciate its advantages. Although but few wells are drilled deep enough below the water level to give a greater ratio than 1 to 1, there are a great many large air-lift pumping plants in California working on both water and oil. An efficiency of 35 per cent may be considered about the average of the results ordinarily obtained.

The air-lift has as many faults as virtues, but when it is possible to rig up some old junk-heap of a compressor and a few pieces of rusty pipe, and produce a good, steady and dependable pump, it is worthy of consideration. Even the absence of valves would enhance the value of it to any one who has ever pulled about a mile of casing and pump rods out of the ground to get at the worn-out valves and leathers of an old deep-well pump.

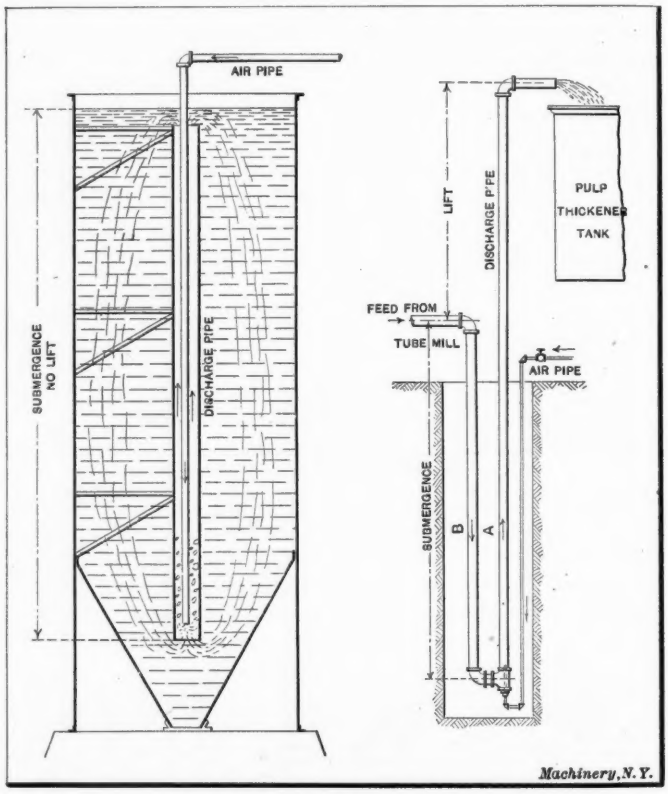


Fig. 3. The Pachuca Tank for Stirring up Ores in Cyanide Solution.
Fig. 4. Elevator for Lifting Tailings

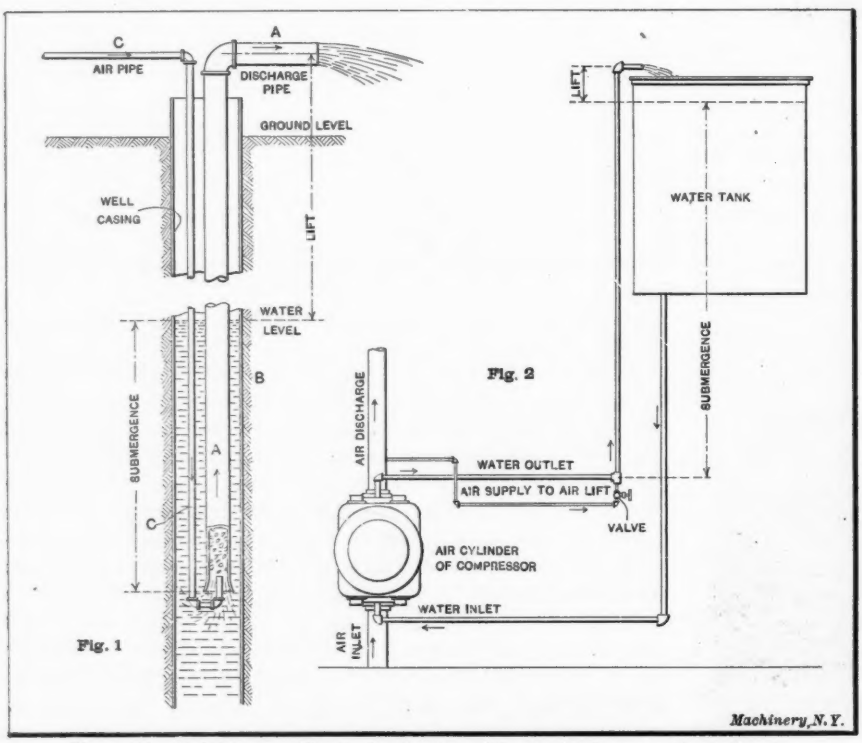


Fig. 1. The Air-lift Pump. Fig. 2. Application of the Air-lift Pump to Circulating Air Compressor Jacket Water

So much for the water pumping air-lift. Consideration will now be given to the possibilities of applying the principle to the mechanical arts. Fig. 2 shows a novel method of circulating the cooling water in an air compressor. The engraving is self-explanatory, and the working of the system shows the same simplicity as does that of the other members of the air-lift family. A slight opening of the air valve will serve to create a brisk motion of the water in the pipes and cooling jacket. A cooling tower might be provided if the water showed a tendency to become quite hot. This cooling tower could be placed upon the tank and the air-lift pipe raised so that the water would flow over the slats of the tower and into the tank. This scheme may be applied to the cooling of ice machines, ammonia condensers, gas engines and transformers.

Fig. 3 shows what is called the Pachuca or Brown agitator, which is used very extensively in cyanide plants for mixing and agitating the finely-ground ore or "pulp" with the cyanide solution. The Pachuca tank consists of a tall cone-bottomed steel tank which has an air-lift pipe in the center and a small pipe for introducing air. The use of the air-lift is, in this case, simply to agitate the pulp and bring it intimately into contact with the cyanide, although the air has a beneficial effect in supplying the oxygen necessary to bring about the dissolv-

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ing of the gold and silver. The time of agitation is usually sixteen hours, but the tendency is toward continuous agitation in several Pachuca tanks operated in series, the pulp running slowly from one tank into the other through the series, the rate of flow being regulated to conform to the time it takes to dissolve the precious metals.

In the case of the Pachuca tanks, the air-lift works under ideal efficiency conditions for the submergence exceeds the lift. No system of mechanical agitation can compete with the Pachuca tank, and it will be seen that wherever agitation is to be carried on, the Pachuca tank can be used, provided that the action of air is not harmful to the substance being handled. The air-lift will handle almost any amount of solids, slimes, or sands in the solution and this would recommend it for pumping such things as pulp, mud or any liquid containing solids which are hard on plunger pumps.

Fig. 4 shows an application of the air-lift, in which it is used to raise the tube-mill tailings into pulp thickeners or classifiers in ore milling plants. The vertical pipes shown are placed in a pit so as to give at least a 1 to 1 submergence. Air is admitted at the bottom of the pipe *A* and the pulp comes in at the top of the pipe *B* down which it flows, and is elevated in pipe *A* by the action of the air.

Many other applications of the air-lift are at present in use, but they all work upon the same principle. These four examples will suffice to give some suggestions which it may be possible to turn to good advantage.

* * *

INEFFICIENCY IN THE BUILDING TRADES

The waste of material and labor in house building is appalling to one accustomed to the economies and precise methods of manufacturing. A contractor seldom makes use of labor-saving devices for reducing cost and improving the quality of the work. Think what the wood trimmer used by almost every pattern-maker would save of the time of a carpenter putting in the trim of a house. Not only would its use save time, but it would insure making joints of mathematical accuracy, if used with intelligence. But this is not the least of the indictments.

The average run of contractors leaves on the premises horses, temporary benches, makeshift miter boxes and many other things that have consumed time and lumber in the making and which have to be made for the next job if not saved. Another indictment is the lack of system in getting material on hand to keep the workmen employed. Time is lost by failing to order lumber, doors, sash and trim promptly. The aggregate loss in the country each year because of these wasteful methods is enormous, and we all feel it in increased first costs, higher rents and dissatisfaction with slovenly jobs that have cost more than first-class work should.

* * *

When you start in to fix a machine, first be positive that something ails it, and then try to make sure of just what ails it.

ALLOWANCES FOR BENDS IN SHEET METAL

Square Bends	Weight per Square Foot		Gage	Thickness, Inches	Amount to be Deducted from the Sum of the Outside Bend Dimensions, Inches						
	Ounces	Pounds			1 Bend	2 Bends	3 Bends	4 Bends	5 Bends	6 Bends	7 Bends
Formed in a Press by a V-die	32	2.000	18	0.05000	0.0833	0.1667	0.2500	0.3333	0.4167	0.5000	0.5833
	40	2.500	16	0.06250	0.1042	0.2083	0.3125	0.4166	0.5208	0.6250	0.7292
	50	3.125	14	0.07813	0.1302	0.2604	0.3906	0.5208	0.6510	0.7813	0.9118
	60	3.750	13	0.09375	0.1563	0.3125	0.4688	0.6250	0.7812	0.9375	1.0937
	70	4.375	12	0.10938	0.1823	0.3646	0.5469	0.7292	0.9115	1.0937	1.2760
	80	5.000	11	0.12500	0.2083	0.4167	0.6250	0.8333	1.0417	1.2500	1.4583
	90	5.625	10	0.14063	0.2344	0.4687	0.7031	0.9375	1.1719	1.4063	1.6436
Rolled or Drawn in a Draw-bench	32	2.000	18	0.05000	0.0667	0.1333	0.2000	0.2666	0.3333	0.4000	0.4666
	40	2.500	16	0.06250	0.0833	0.1666	0.2500	0.3333	0.4166	0.5000	0.5833
	50	3.125	14	0.07813	0.1042	0.2085	0.3127	0.4169	0.5212	0.6254	0.7296
	60	3.750	13	0.09375	0.1250	0.2500	0.3750	0.5000	0.6250	0.7500	0.8750
	70	4.375	12	0.10938	0.1458	0.2917	0.4375	0.5833	0.7292	0.8750	1.0208
	80	5.000	11	0.12500	0.1667	0.3333	0.5000	0.6666	0.8333	1.0000	1.1666
	90	5.625	10	0.14063	0.1875	0.3750	0.5625	0.7500	0.9375	1.1250	1.3125

BENDING SHEET-STEEL FOR METAL FURNITURE

By K. GEORGE SELANDER*

In view of the fact that but little information has ever been published concerning the bending of the sheet metal used for ornamental purposes, the writer trusts that the data embodied in this article will prove useful. The work for which this data has been developed refers more particularly to the bending of sheet metal for counters, bank fittings and general office fixtures, for which purpose it is not absolutely essential to have the legs of the bends within very close limits. Absolutely accurate data for this work cannot be deduced, as the stock varies to a great degree as regards material, hardness, etc., though experience has shown that the figures given may be safely employed for sheet steel, aluminum, brass and bronze. In the use of the table, caution should be exercised in the choice of the proper gage, for on account of the differences in the gage systems the results might be erroneous. It is therefore advisable to use the decimal equivalent.

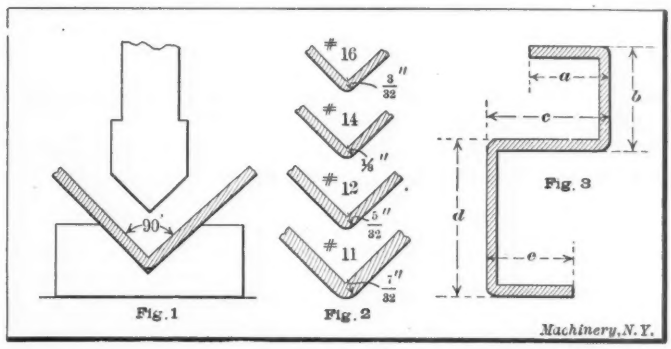

Fig. 1, V-die for Bending Sheet Metal. Fig. 2. Radii to which Corners are bent. Fig. 3. Illustrating the Meaning of the Sum of the Outside Bend Dimensions

The bends made in a V-die will be the first considered. The manner of forming and the radii to which the outside corners are bent are shown in Figs. 1 and 2. From experience it has been found that for the semi-square corners, such as are formed in the V-die, the amount to be deducted from the sum of the outside bend dimensions represented in Fig. 3 by the sum of the letters from *a* to *e*, is as follows:

$$X = 1.67\,B\,G$$

where X is the amount to be deducted; B, the number of bends; and G, the decimal equivalent of the gage. The values of X for different gages and numbers of bends are given in the accompanying table. Its application may be illustrated by an example: A strip having two bends is to have outside dimensions of 2, 1½ and 2 inches, and is made of stock 0.125 inch thick. The sum of the outside dimensions is thus 5½ inches, and from the table the amount to be deducted is found to be 0.4167; hence the blank will be $5.5 - 0.4167 = 5.0833$ inches long.

The latter part of the table has been developed for square bends which are either drawn through a block of steel made to the required shape, or else drawn through rollers in a draw-bench. The pressure applied not only gives a much sharper corner, but it also elongates the material more than in the V-die process. In this case the deduction is

$$X = 1.33\,B\,G$$

* * *

In making aluminum castings of complicated shapes, the sand should be rammed as soft as possible in order to allow the shrinkage of the metal in cooling to take place without rupture of the casting.

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ECCENTRICALLY LOADED RIVETS

By JESSE LONG

Mr. M. Terry in his article on "Eccentrically Loaded Bolt and Rivet Groups" in the August, 1910, issue of MACHINERY, engineering edition, states that in the case of the cantilever shown in Fig. 1, the moment of resistance of the four rivets on the circle of 3-inch radius equals that of the rivets on the circle of 4¼-inch radius. To prove this, he assumes that the pressure on each rivet varies inversely as its distance from the center; this assumption is correct only when the rivets are at equal distances from the center, as in Fig. 2. In this case

$$Wl = 4\,rp;\ \text{or}\ P = \frac{Wl}{4\,r};$$

that is, when r increases P decreases r being the radius and P the load on each rivet.

But is it true when the rivets are not at equal distances from the center, which is the case in Fig. 1? Consider Fig. 3;

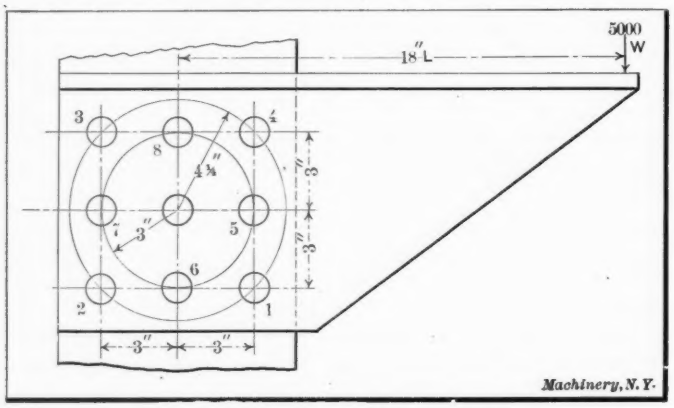

Fig. 1. Eccentrically Loaded Rivet Group

here is a cantilever pivoted at A, and held by rivets 1 and 2. The dotted lines show strain caused by load, exaggerated for the sake of clearness. It is evident that the strain is proportional to the distance of the rivets from the center; but stress is proportional to strain, within elastic limit; therefore

$$\frac{f_1}{y_1} = \frac{f_2}{y_2};\ \text{or}\ f_2 = \frac{f_1\,y_2}{y_1}$$

where f_1 and f_2 are the stresses per square inch, and y_1 and y_2, the distances from the center, for rivets 1 and 2, respectively. Referring now to Fig. 1,

$$W\,L = 4\,f_1\,a y_1 + 4\,f_2\,a y_2$$

where f_1 and f_2 are stresses per square inch; y_1 and y_2, radii for outer and inner circles of rivets, respectively; and a, the

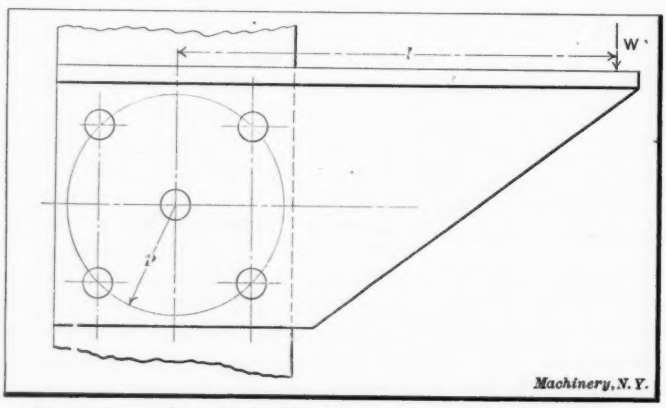

Fig. 2. Eccentrically Loaded Rivet Group—Rivets all at Same Radius

area of each rivet. Substituting the value found for f_2 the equation becomes

$$W\,L = 4\,f_1\,a\,y_1 + \frac{4\,f_1\,a\,y_2^2}{y_1}$$

This may be expressed as

$$W\,L = \frac{4\,f_1\,a}{y_1}\,(y_1^2 + y_2^2);$$

That is, the moment of resistance of each rivet varies with the square of its distance from the center. The last equation gives

$$f_1\,a = \frac{W\,L\,y_1}{4\,(y_1^2 + y_2^2)}$$

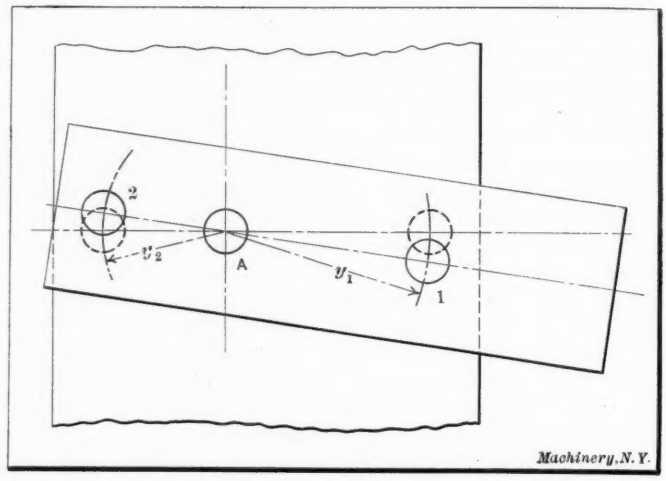

Fig. 3. Cantilever with Rivets at Unequal Distances to represent Intensity of Stress

Using the figures given in Fig. 1 in the above equation

$$f_1\,a = \frac{5000 \times 18 \times 4.25}{4\,(18.06 + 9)}$$

$$= 3536 \text{ pounds.}$$

This is the shearing load on each rivet in the outer circle,

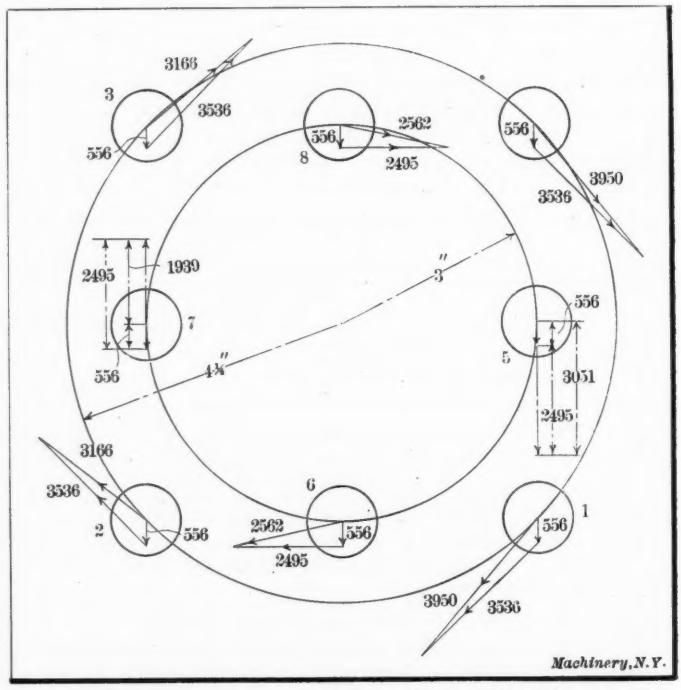

Fig. 4. Rivet Group with Vector Diagrams showing Load on Each Rivet

due to moment of W. The shearing load on each inner rivet, due to moment of W is

$$f_2\,a = \frac{f_1\,a\,y_2}{y_1} = \frac{3536 \times 3}{4\ 25}$$

$$= 2495 \text{ pounds.}$$

The direct and tangential shearing loads on each rivet are shown in Fig. 4, and also the geometrical sum of the loads on each rivet. The greatest load is on rivets 1 and 4 and amounts to 3950 pounds, or slightly less than the 4400 pounds allowed as the safe load for a ¾-inch rivet.

* * *

The Boston & Maine Railroad is gradually substituting the telephone for the telegraph for train dispatching. It now uses the telephone on lines over 230 miles in length. The New York, New Haven & Hartford Railroad has also equipped about 100 miles with a telephone system.

THE CUSTER PROCESS OF CASTING IN PERMANENT MOLDS

ITS HISTORY, THE METHODS EMPLOYED, AND ITS EFFECT UPON THE METAL CAST

By ERIK OBERG*

From time to time articles have appeared in the engineering press describing different phases of the Custer process of producing castings in permanent molds—that is, molds made of metal, and hence of a permanent nature, as distinct from the sand mold which disintegrates for each casting made. This process has been developed by Edgar A. Custer, president of the Tacony Iron Co., Philadelphia, Pa., and the articles so far published have mostly been in the nature of abstracts of papers read by Mr. Custer before various societies. Many of these papers were prepared and published while the process was still—to some extent—in its experimental stage, and while many isolated examples illustrating the application of the process were given, it is only recently that data indicating the full scope of its possibilities, and the effect upon the metal thus cast, have been available for publication. The development of this process may be considered as one of the great epochs in the history of the iron industry—this development opening the way for unheard of possibilities in the future methods of foundry as well as machine shop practice, the extent of which it is at this stage impossible to fully appreciate or foresee. For this reason it has been deemed advisable to present in MACHINERY a complete account of the present state of this process—revolutionary alike from the molder's and the machinist's point of view. In order to make the following article authoritative, the writer was sent to obtain, from the inventor personally, the information contained in the following; at the same time an opportunity presented itself for the writer to personally see the process in use, for demonstration purposes, at the plant of the Best Mfg. Co., of Verona, near Pittsburg, Pa., where the half-tone illustrations of the machines exhibited, which accompany this article, were obtained.

History of the Process

It cannot be said that the permanent mold, or the process of casting in permanent molds, is new. For many years small iron castings have been produced in metal molds with comparatively good success. It must be remembered, however, that the castings produced were chilled to an extreme hardness, and that they were invariably very small. On account of the hardness of the chilled metal it was not possible to machine the castings, and hence the process had only a very limited application.

In 1902, Mr. Edgar A. Custer began to undertake extensive experiments at the Tacony Iron Works, in order to ascertain if it were not possible to produce a soft iron casting in a permanent mold. As the main product of the company is sewer pipe, the experiments were conducted with castings of this type. At first various coatings were used in the molds, such as a mixture of oil and graphite, for example, but without success. The castings produced were too hard to permit of machining. As a result of the continued experiments it was finally found, in 1906, that a soft "machinable" casting could be produced in a simple cast-iron mold, if no coating at all were used in the mold, and if the casting were removed from the mold as soon as it had set and while it was still at a high red heat. As a result of the successful method thus developed, a machine for casting pipes in permanent molds was designed in which 240 pipes an hour could be cast. This machine, together with the method for operating it, was described in MACHINERY, September, 1908, engineering edition, and it is, therefore, not necessary to again describe it in detail. It may be mentioned, however, that the machine consisted of 30 molds; each mold was poured every 7½ minutes. A core consisting of a cast-iron hollow arbor covered with sand was used. The process proved successful for the casting of pipes and suggested the casting of fittings in permanent molds as well.

* Associate Editor of MACHINERY.

The problems met with in the casting of pipe fittings were of a somewhat different nature from those met with in the casting of pipe. The fittings, in general, were of a more complicated shape, and the coring of them presented difficulties. It was found impossible to use sand cores successfully in the casting of fittings, owing to the irregularity in the form of the cores. It was practically decided to discontinue the experiments for producing cast-iron fittings in permanent molds, when, as a last resort, plain cast-iron cores were suggested and tried. The very first experiment with cast-iron cores proved successful, and the way was now open for a practically limitless development and application of the process. With a cast-iron mold, requiring no coating, and a cast-iron core, practically any casting of not too complicated a shape could be successfully made in a permanent mold, both from an engineering and a commercial point of view. Since that time, when the governing principles of casting by this process were thoroughly established, the process has been gradually developed so that now castings of a variety of shapes—fittings, flanges, brake shoes, cast gear wheels, both of the spur and bevel type, truck wheels, mining car wheels, etc.—are produced successfully by this method.

The Mold and the Cores

The molds and cores are made from ordinary gray cast iron, of the same kind and quality as that ordinarily used for sewer pipes and fittings. One of the most important considerations with relation to the mold is, of course, its life. As yet, no definite answer can be given to the question of the life of a permanent mold of the type described, because no molds have as yet been in use long enough to have outlived their usefulness. Some have been used continuously for five years and are still in good condition. The only points where the molds will disintegrate are in the runners and the gates. After from 7000 to 10,000 castings have been made in a mold, the gates are generally renewed by inserting new blocks containing the gates. In doing this work, it is of especial importance to see that no joints are made at any point where the molten metal strikes when in its most liquid state, as this quickly causes disintegration of the mold. In general, the molds should have as few joints as possible; that is, they should not consist of any more parts than is absolutely necessary. Usually, the mold is simply made out of two solid blocks of cast iron, each containing about one-half of the mold. One reason for avoiding joints is to prevent deterioration, and another important reason is that the heat conduction is retarded by a joint a great deal more than by solid metal. The necessity for a rapid distribution of the heat into the mold itself, and for radiation of the heat, is self-evident.

It might be suggested that some system of water cooling would aid in rapidly cooling the molds. This has been tried, but found unsuccessful. The effect of water cooling was to produce a tendency of the molds to crack toward the water chamber. A uniform cooling of the mold could not be effected, and strains were set up in the mold itself.

The cost of the repairs necessary with relation to the gates amounts to about 10 per cent of the original cost of the mold. The matrix of the mold has not as yet, in any case, shown signs of wear or disintegration. In one mold 21,000 castings have been made, these castings weighing 10 pounds each, and the original tool-marks are still visible in the matrix. One very interesting and important feature in this connection is the fact that the life of the mold does not depend so much upon the number of castings made in it as upon the number of times that it is permitted to become cold after having been heated by pouring the molten metal into it. A mold which is worked continuously will last for about four times the number of castings before repairs are required, as compared with one that is used at intervals only.

In making the molds, several points must be considered. Loose parts, if inserted in the mold, must be held as lightly as possible, as otherwise the mold will be destroyed by the effect of the expansion due to heat. All joints directly acted

upon by the hot metal, or influenced by the expansion due to the heat, must be of the expansion type. The molds themselves are made of large bulk so that they will have a great heat capacity. Another object of making the molds of large bulk is to prevent distortion from the heat. A small vent is provided in the top of the mold to permit the air to escape. The general construction of the molds, as shown in the accompanying illustrations, also aids the air in escaping easily.

Operating the Molds

The operation of the molds was described by Mr. Custer in a paper read before the February meeting of the New

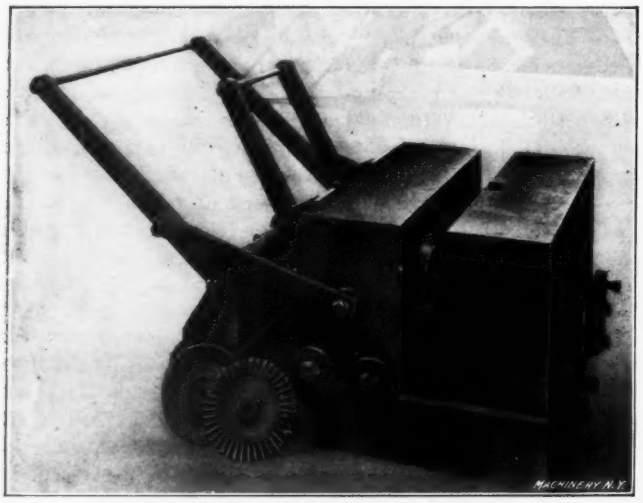

Fig. 1. Permanent Mold for Casting Bevel Gears

England Foundrymen's Association. The operation is very simple, and requires little or no training or skill.

In practice, the molds are placed in batteries. Eight and ten molds constitute a battery, and at each of these batteries a gang of men, generally four or five laborers, is placed. A large ladle, holding 150 to 200 pounds, usually sufficient to pour all the castings in one battery, is pulled on a trolley, and the ten molds poured as fast as the pourer can fill each mold and move to the next one. The other men follow up this operation and take out the castings from the molds, seeing that the latter are thoroughly cleaned and closed, ready for the next operation. By this method ten castings are generally poured, in from two to four minutes, and the time necessary to make one casting is the time that is necessary to pour this one casting and move to the next mold. If iron be continuously supplied to the batteries the work can go on all day without interruption.

In the earlier experiments, the molds as well as the cores were occasionally coated with a thin mixture of oil and graphite, but at the present time no coatings are used, as they tend to prevent the rapid conduction of the heat from the surface of the poured casting, which is one of the most important of the principles involved. No special care need be exercised to prevent the castings sticking to the mold. They are very easily removed, and the only portion that may stick to some extent is the sprue in the gate, but even this is removed in an instant by a suitable tool.

The rapidity with which castings can be produced by this method is remarkable. Very small castings can be cast at the rate of four a minute. Small pipe fittings can be cast one every two minutes, but for medium-sized castings, weighing from 10 pounds up, it is not recommended to pour oftener than every four minutes into the same mold. With a battery of ten molds, however, 150 castings can be produced per hour. In the case of large pipes, one casting out of every mold for every eight minutes is considered a practical average. The molds are, in general, designed to produce 1000 pounds of castings per day, in the case of comparatively small castings. In the case of large castings, much better results can be obtained. As an example, it may be mentioned that in one case 18 tons of castings were produced in 37 molds in 10 hours in a floor space of 60 by 26 feet. To produce the same tonnage of the same castings in sand, a floor space of 400 by 105 feet would have been required, or an area about 27 times as large.

When a casting is made in a permanent mold, the cores must be withdrawn quickly as soon as the metal has set, as otherwise the iron will shrink and grip the core so that it cannot be withdrawn. This condition, however, is not as serious as might be at first assumed, because if the cores should be gripped by the casting, all that is necessary to do is to open the mold and break the casting with a hammer. This releases the core without injury to either the mold or core, and the only loss is that of the labor required to produce the casting, which is of little account. In this connection it may be of interest to point out the difference between the loss of a casting made in a permanent mold and one made in sand. In the former case, the mold remains intact, and all the loss involved is that of the labor required for pouring and making the casting lost, which is a question of a minute's time, perhaps, at most. In the case of the loss of a sand-molded casting, the mold itself is lost and the labor expended in making it, which is a very considerable item. To further emphasize the difference, it may be mentioned that the amount of bad castings when made in permanent molds is only 1 to 2 per cent, while with a similar class of castings made in sand molds, the loss in bad castings is from 5 to 15 per cent. The loss from bad castings in the permanent mold process may, therefore, be considered as of hardly any account.

Principle of the Process

The reason that it is possible to produce soft castings in a permanent metal mold is due to the fact that a certain time elapses between the point at which the molten metal will set and the temperature at which it will begin to chill. This interval is long enough to give the operator of the mold time to remove the casting from the mold before chilling begins. At this time the casting is still at a bright red heat, but the sudden contact with the cooler surfaces of the mold

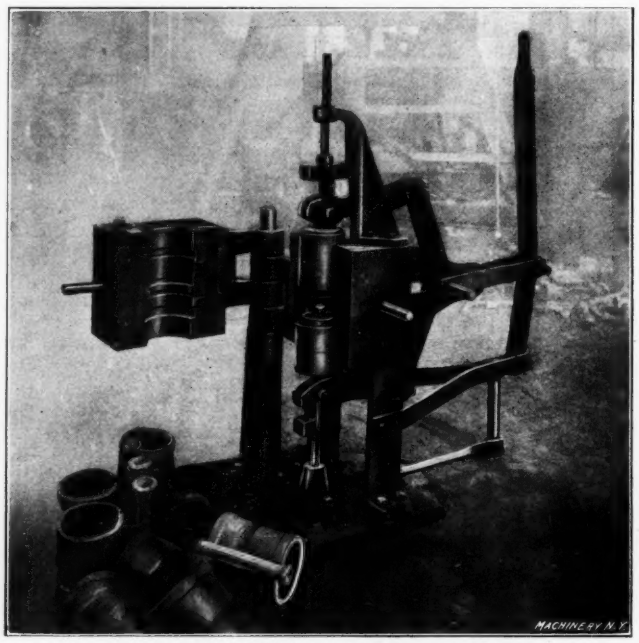

Fig. 2. Mold for Casting a 5- by 4-inch Reducer

has made the surface of the casting sufficiently hard so that it can be handled without fear of distortion or breakage. It has been definitely determined that the iron does not chill until some time after it has set, and the main point in the design of the molds is to have them so arranged that, in the first place, the iron will set quickly, and in the second place, the operator can then quickly remove the casting from the mold before chilling begins. In general, the castings are removed from the molds about five or six seconds after the pouring has been completed. When castings are of such a nature that permanent cores are used, the cores are withdrawn immediately after the completion of the pouring, and then the casting is removed from the mold after six to ten seconds.

When the molten metal is first poured into the mold it swells until that point has been reached at which it begins to set. The bulk of the metal remains at this volume for

a short period of time, and then begins to shrink. In the permanent mold, however, the metal on the surface sets firmly at the moment it has reached its largest volume, and remains in the shape and volume thus assumed, because the interior metal is now so much softer that it adjusts itself to the condition and form of the outside. As will be later referred to, it is a remarkable condition that castings made by this process have apparently no shrinkage strains set up in them. As the metal sets when it has assumed its largest volume and completely filled the mold, the casting becomes an exact duplicate of the mold, and even the toolmarks in the mold are frequently visible on the casting.

Characteristics of Metal in Castings made by this Process

We now come to one of the most remarkable facts in connection with the process described. The characteristics of the iron in the castings made in permanent molds are entirely different from those of sand castings. Although the same pig iron is used in producing castings by the two processes, the qualities of the iron in the castings are entirely different, and no direct comparison can be made between the quality of the products. The casting produced in a permanent mold is a different metal, so to speak, from the casting made in a sand mold, although both may be poured from the same ladle. The difference, however, is not chemical, but of a purely physical nature. Mr. Custer himself refers to the properties of the permanent mold casting as follows:

The permanent mold castings differ from the sand castings not only in their physical structure, but also in their characteristics. A soft, open pig iron, high in graphitic carbon, becomes a close-grained iron, showing no traces of the graphitic flakes, but having the same amount of carbon as existed in the original pig iron. This close-grained iron is capable of being magnetized, permanently retaining the magnetism; it can be tempered and hardened precisely the same as a bar of tool steel, and, when tempered, will make a cutting tool equal to the best non-alloy carbon steel. This latter fact is true, irrespective of whether the original pig iron is high or low in silicon. There are no spongy spots, and the castings are free from shrinkage strains. The castings can be

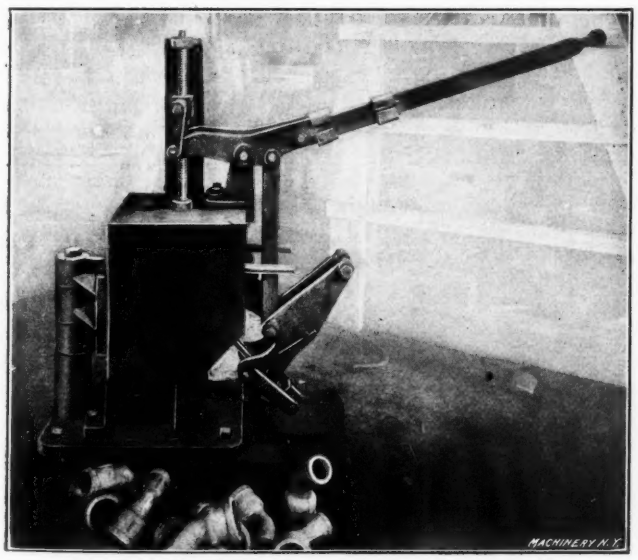

Fig. 3. Mold for Pipe Bends—Mold closed ready to pour

taken from the mold at a bright red heat and plunged in water until cold without showing a sign of cracks. High shrinkage does not begin in a permanent mold until a very low heat is reached, 1200 degrees to 1400 degrees F. being the point at which the casting must be removed to prevent cracking the undercut parts. Again, when a permanent mold casting is hardened until it is "unmachinable," it only requires heating once to a red heat to restore it to a soft, strong metal. None of these characteristics is shown in sand-made castings, and it must be borne in mind that these characteristics are invariably present in a permanent mold casting.

It might be inferred from the foregoing paragraph that the process of casting iron in permanent molds may entirely revolutionize the present method of making cutting tools from carbon steel. It would seem that lathe tools, planer tools, milling cutters, etc., could be cast in permanent molds and give as good service as those made from ordinary carbon tool steel. This is, however, not possible, at least not at the present stage of the development of the process. While the iron cast in permanent molds possesses hardening qualities equal to tool steel, the cast metal still retains the brittleness of cast iron, it has not the tenacity or ductility of steel, it cannot be forged, and if used as a cutting tool, it is liable to chip and break if subjected to shocks. Nevertheless, milling cutters have been made from

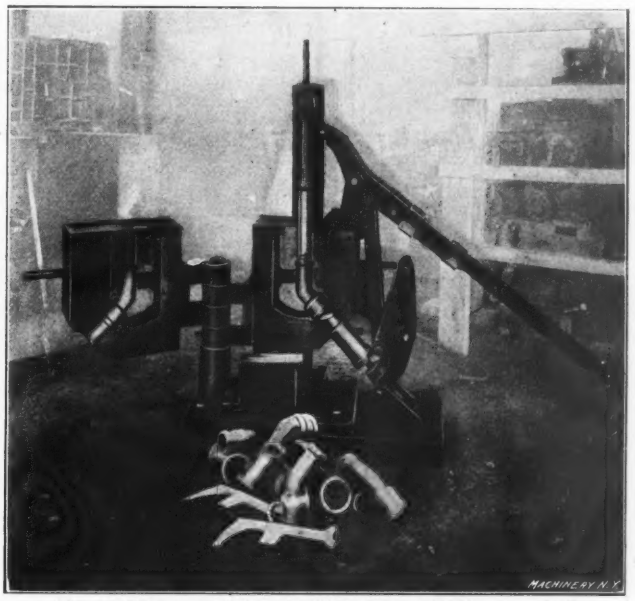

Fig. 4. Mold opened, Cores withdrawn and Casting removed

the metal for demonstration and experimental purposes, that have given proofs of possessing the required cutting qualities.

In case milling cutters were to be made by this process, it might also be inferred that the teeth could be cast right in the mold, and merely ground after hardening. This, however, would be impracticable, because the thin edges of the teeth would cool so rapidly as to be chilled in the mold, after which all the properties referred to as present in the metal would be lost. If it ever should prove practical to make cutters of this metal, it would be likely that only the blanks would be cast, and then the teeth cut as usual. It must be remembered that even in this case a material saving would result. The material in the blank would be as cheap as ordinary cast iron, and the teeth could be cut at a rate, perhaps four times as fast as the teeth in a tool steel blank, because the metal is very soft before hardening. It is not possible to go further into this phase of the subject at the present time, however, because further investigations will have to be made before any practical commercial results with this metal used as a cutting tool can be expected.

The hardening qualities of the permanent mold cast iron are, however, of great importance, even though the metal may not be suited for cutting tools. When hardened it is an excellent substitute for hardened tool steel in cases where it is required to stand steady wear. It presents the same hard surface, and if not subjected to severe shocks, will give satisfaction. The hardness of the metal depends upon the temperature to which it is heated before quenching. It will not harden at all if heated only to a dull red heat. If heated to a bright cherry red heat, it will become as hard as hardened and tempered tool steel. If heated to a yellow heat, it will become glass hard; in fact, it is possible to obtain a sufficient hardness to make it capable of scratching glass. The temper is not drawn, as the desired degree of hardness is governed by the hardening temperature.

When hardening permanent mold cast iron, it must be quenched in ice-cold water. If quenched in boiling water, it

will crack almost invariably, and dipping it in oil has no hardening effect whatever. To anneal the piece, after it has been hardened, all that is necessary is to heat it to at least the hardening heat, or to a slightly higher temperature, and permit it to cool in the air. The effect of the hardening is to slightly lighten the color of the section, but there is apparently no change in the grain or physical structure of the metal.

Effect of Impurities

As to the effect of impurities in the pig iron, Mr. Custer said before the New England Foundrymen's Association that the hardening elements which make it difficult to produce a "machinable" casting in permanent molds are sulphur and manganese. Phosphorus has little or no effect; it produces no weakening of the metal even when used in quantities as high as one per cent. The function of silicon is simply that it lengthens or shortens the interval between the setting point and the chilling point, according to whether the silicon content is low or high. Manganese, in excess of 0.60 per cent, is a detriment. It does not increase the strength of the casting, but it renders it brittle and weak. It is to the permanent mold process what sulphur is to the modern foundry.

Absence of Shrinkage Strains

Castings produced in permanent molds have no shrinkage strains. Molten iron is homogeneous and if this iron were instantly chilled beyond the setting point it would still be homogeneous; there would be no chance for segregation. The sulphur, phosphorus and carbon would remain in the same relative positions that they occupied when in the molten state, but since the mass was all cooled at precisely the same rate, it becomes evident that no shrinkage strains could be possible. It is obviously impossible to cool iron instantly, but approximately the same result can be obtained if it can be chilled fast enough to prevent segregation. If a casting, say one square inch in section, be made in sand, it would require at least a minute before it could be removed from the sand without breaking or distorting. In this time the different elements segregate and different portions of the bar are cooled at different rates. Consequently, shrinkage strains are set up that become more marked when a portion of the casting is much thinner than the other, or when a thin section is joined to a heavy section at right angles. A permanent mold casting of this thickness, however, can be removed from the mold within two seconds after it is poured and the time in which segregation is possible is reduced from 60 seconds to 2 seconds. Hence, all the ingenuity of the designer is bent toward the construction of a mold for introducing the metal and removing the casting in the least possible time.

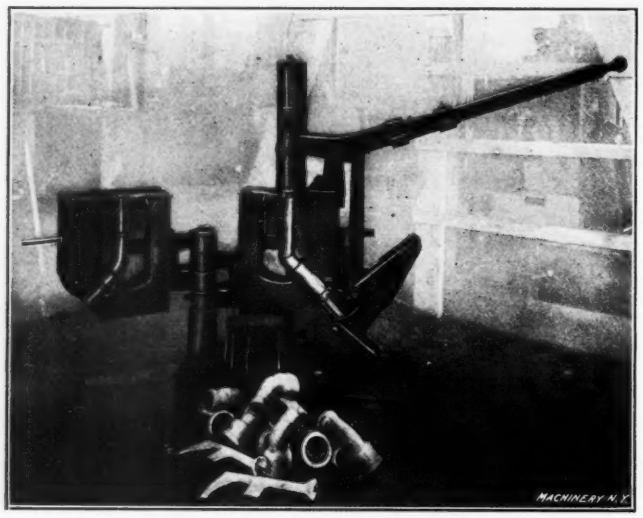

Fig. 5. Cores in Position, Mold open

As an example of absence of shrinkage strains, the following case may be cited. A piece 2½ inches in diameter and ½ inch long was cut off from a cast-iron fitting, cast in a permanent mold. This piece was bored out with an eccentric hole, so that the thickness of the wall was ⅜ inch on one side, and ⅛ inch on the opposite side. Then a thread was cut on the inside, and the dimensions of the piece carefully measured. Now the piece was heated ten times to a bright red heat, and dipped each time in cold water, but no distortion could be detected. After fifty repeated heatings and coolings, a distortion of 0.002 inch was recorded in the diameter of the piece. An ordinary sand casting made from the same iron, and prepared in the same way cracked to pieces after the third cooling. The permanent mold casting thus differs from the sand mold casting also in that it does not "grow" when subjected to repeated heating and coolings. This is one of the valuable characteristics of this product.

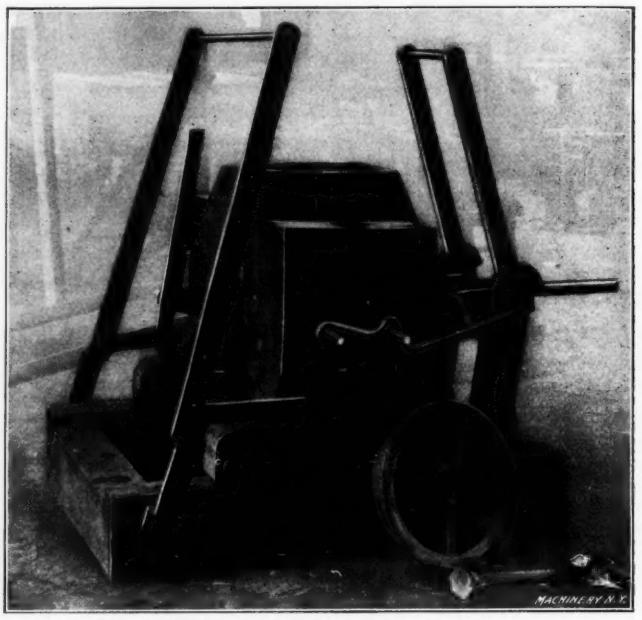

Fig. 6. Mold for Mining Car Wheels, ready to pour

The reason for the peculiar properties of the iron cast in permanent molds is to be found in the fact that the carbon in it is not found in the graphitic form, as in ordinary cast iron. The absence of shrinkage strains is explained by reference to the method of cooling the casting. The phenomena are explained by Mr. Custer as follows: Carbon exists in molten iron in solution, and is then in the combined form. If molten iron is instantly chilled and solidified, all the carbon will still be in the combined state, and there will be no free carbon in the metal, assuming that the metal could be chilled instantly to a black heat. In actual practice, when the iron is chilled swiftly from the molten state, as in the permanent mold, all the carbon at the time of setting is in the combined form, but as it cools a certain proportion of the carbon is changed into the free state, although not to the form which is commonly known as "graphitic." The free carbon collected after dissolving the iron will be found to exist in such a fine powder as to have no crystalline formation, even under a high-power microscope. This form of carbon is commonly known as "annealing" carbon and will be found in malleable castings. It is a desirable form of carbon, and in order to get it in as large a proportion as possible it becomes necessary to chill the metal swiftly, and to do this

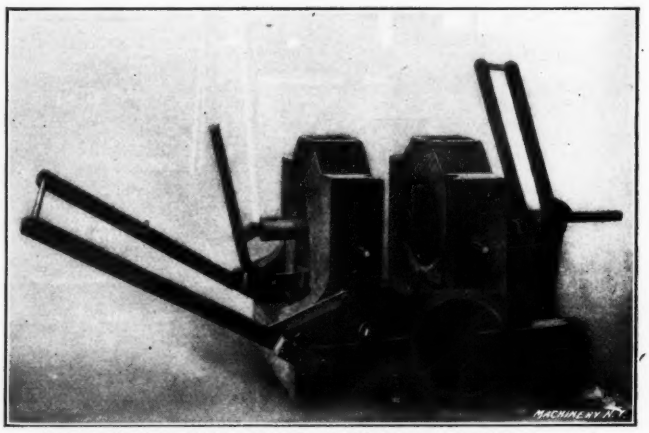

Fig. 7. Mold for Mining Car Wheel, Mold open, Casting removed

it is necessary to use large iron molds of so great a bulk that their heat capacity is sufficient to accomplish this result and, at the same time, not overheat the molds.

The point next to be considered is that while it is evident that this sudden chilling can be accomplished with castings having a thin section, with castings having a thick section, say two inches square, it would be necessary, in order to set them to their full thickness, to hold them in the mold so long that the outer portion would become chilled. Here is where the well-known fact that iron increases in bulk from the molten state until it reaches the

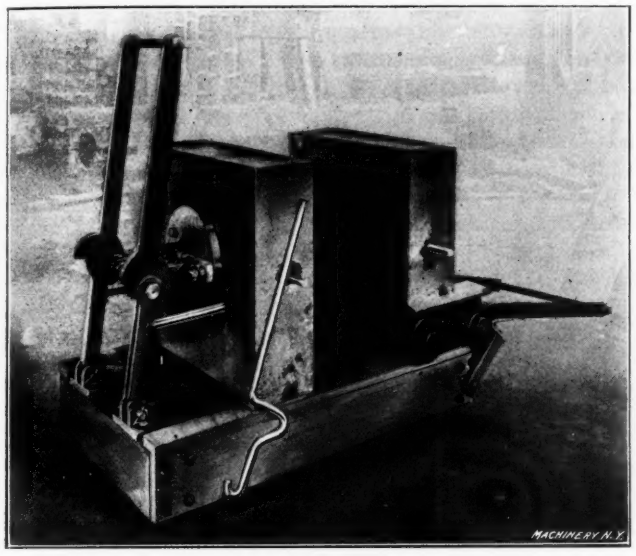

Fig. 8. Mold for Casting Heavy Pipe Flanges

point of setting is taken advantage of. Thus, when a casting of large section is poured in an iron mold of the required bulk, the outer portion, say ⅜ inch in depth, sets almost instantly, and the interior of the casting remains molten. At this point it is removed from the mold and the casting now has a hard set exterior with the interior in the molten state, and, as it loses its heat, the molten iron in the center tends to expand. This expansion is held in check by the hard walls. The force, therefore, is turned back upon the molten metal, and this produces, when cold, a uniform, fine grain from the center to the outside of the casting. There can be no chilling of the metal, since the casting is removed from the mold before the chilling point is reached and the natural physical force of cooling accomplishes the desired result. It is well known that it is almost impossible to cast a ball 6 inches in diameter, in a sand mold without the interior being more or less spongy. When the same ball is cast in a permanent mold, the whole ball is of a homogeneous structure throughout.

Economy and Scope of Process

It is evident that where a great many duplicate castings are to be produced, the process of casting in permanent molds makes it possible to produce castings very much cheaper than by sand molding. Ton for ton of castings produced, the first cost of the molds is ordinarily only one-half of the cost of patterns, cores, sand and flasks; and the labor cost is very much less, because the skilled molder required for sand molding can be substituted by a laborer, so that this cost, on a tonnage basis, can often be reduced to one-third.

As an example, it may be stated that in a case where a good molder can cast, in sand, about 900 pounds a day, the production of one laborer working with permanent molds averages one ton a day. As the molder's wages are nearly double that of the laborer, the difference in cost, on a tonnage basis, is considerable. When using permanent molds it is, of course, necessary for economical production that iron be furnished to the molds continuously, and the great advantage of the process as regards quantity of product lies in the fact that castings can be made continuously all day. The only skill that is required in working with the molds is that of pouring the metal at a uniform rate, but this skill a man can acquire in a short time. The castings come out of the molds with a very clean surface, and no chipping is required except to remove a slight fin formed where the molds come together, similar to the fin on a drop forging.

It is evident that small castings can be produced at a more rapid rate than large ones, because they do not heat the mold so fast. It has been found that the molds will deteriorate quickly if raised to a red heat, so the time elapsing between each pouring must be gaged according to the size of the casting and its consequent heating effect on the mold.

The heaviest casting that has so far been made by this process weighs 200 pounds, but there is apparently no good reason why much heavier castings cannot be produced by the process. In fact, molds are now being made for a casting which will weigh 750 pounds. As examples of work cast in permanent molds, may be mentioned 6-inch sewer pipes, 5 feet long, weighing 100 pounds; mining car wheels weighing 100 pounds; and heavy 6-inch T-castings weighing about 200 pounds.

The process is not applicable to the making of a few castings of a kind, on account of the expense of the molds. It occupies in this, as well as in many other respects, the same relation to the regular foundry practice as the drop forging process does to ordinary blacksmith shop work. If the casting is small and simple, it may pay to make a mold for a couple of hundred castings, but, in general, the process is only used where several thousand duplicate castings are to be made. It is at the present time being used by two large concerns besides the Tacony Iron Co., and efforts are being made

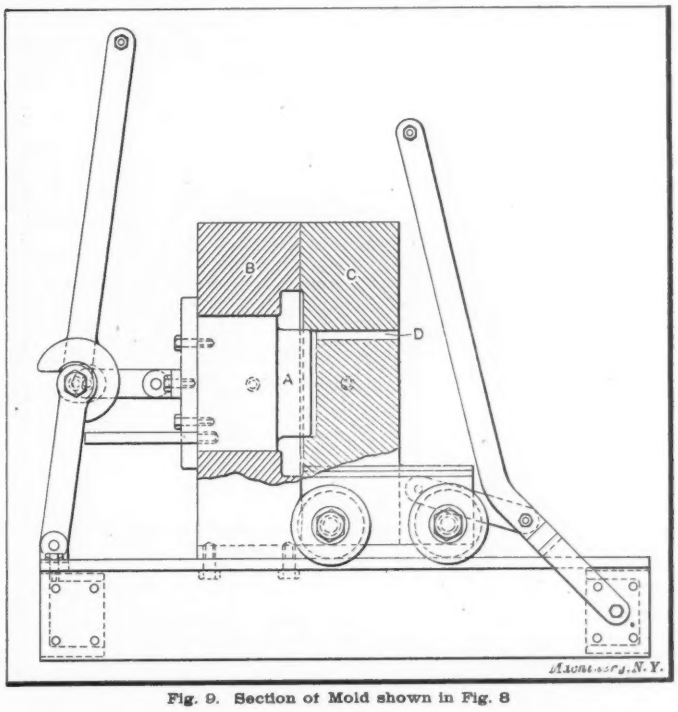

Fig. 9. Section of Mold shown in Fig. 8

to interest several other firms in securing the rights to use the process in their plants.

Experiments have also been carried on with the permanent molds for making castings of steel, brass and bronze. With manganese bronze the same success as with cast iron has been attained, but the other experiments have not as yet been carried to a point where any definite statements as to the application of the process can be made. The experiments, however, are continued, and judging from the results so far obtained with cast iron, it is reasonable to expect that, with certain modifications, perhaps, it can be used for other metals as well.

Advantages of the Process

To sum up, the main advantages to be gained by casting in permanent molds are the uniformity of the metal cast, the absence of shrinkage strains, the exact duplication of

the mold, and the cheap production cost. The molds themselves are made comparatively cheaply for most shapes. The matrix is milled and bored out, and ordinary machine finish is all that is required. The process also introduces another possibility not found in the sand molding method. It is possible to produce a casting partly soft and machinable, and partly chilled and hard. This effect is accomplished by removing the mold from contact with the iron at such points as are required to be soft almost immediately after pouring, but permitting the parts to be chilled to remain in contact with the mold for a somewhat longer period. An example of this will be referred to in the following concrete examples of actual work done.

Examples of Molds and Castings Made

The accompanying illustrations show a number of the molds used. The mold shown in Fig. 1 is used for making two bevel gears at one pouring. The gears are 8½ inches in diameter and weigh 7½ pounds each. Two gears, one showing the face and one the back side, will be seen in the illustration. One of the requirements for these gears is that the teeth shall be as hard as possible, while the hub part must be soft so as to be easily machinable. This is accomplished in the following manner: About two seconds after the metal

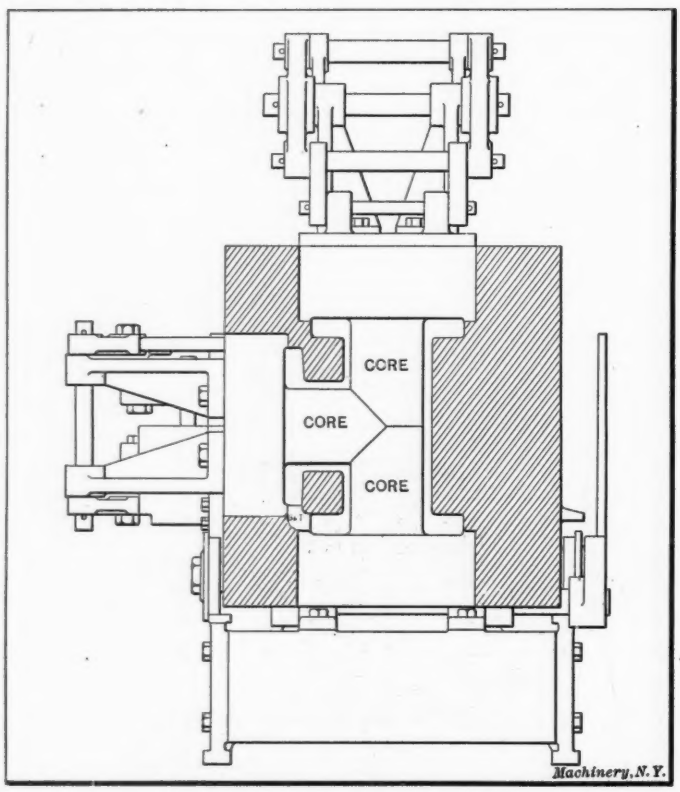

Fig. 10. Mold for a Heavy T-casting

has been poured into the mold, the cores are withdrawn by operating the smaller of the two hand levers shown to the left of the mold. The mold is also slightly opened so as to remove the back of the gear from the chilling influence of the mold. This is done by operating the larger of the two hand levers. Then about four seconds is allowed for hardening the teeth, after which the larger lever is operated to open the mold as far as its design permits. In doing so, the two large center plugs, one of which is clearly shown in the illustration, are forced forward, throwing out the casting between the molds, from where it is then removed by a pair of tongs.

The whole operation, from the beginning of the pouring until the casting is removed from the mold, does not occupy more than 15 seconds. A mold of this type can be poured about every four minutes, and about ten molds would be used in a battery, thus producing 300 gears an hour. The gate of this mold is placed in the center, and the metal flows from the common gate to the gear-molds on each side. Small vent holes are provided in the face of the left-hand mold as shown. There is very little trouble with entrapped air, however, on account of the fact that the molds are made in two sections separated vertically, which permits the air to escape between the halves of the molds as well as through the vent hole. Practically all the molds are made so that they part in a vertical plane, this being done especially in order to facilitate the operation and the rapid removal of the finished casting.

In Fig. 2 is shown a mold for making a 5 by 4 inch reducer, the metal in this being ¼ inch thick, and the casting weighing about ten pounds. In this case one-half of the mold is hinged so that it can be easily opened and closed. The cores are shown parted from each other, but not fully withdrawn. When the mold is closed, ready to pour, the strap shown bolted to the top of that part of the mold which is swung out in the illustration, rests on top of the stationary part of the mold, thus preserving the alignment. When in operation, the vertical lever to the right is thrown back immediately after the pouring is finished, this motion withdrawing the two cores. Immediately after having withdrawn the cores, the mold is opened and the casting is taken out. The total time required from the beginning of the pouring until the casting is taken out from the mold is about eight seconds.

Figs. 3, 4 and 5 show different views of a mold for making 2-inch eighth bends. In Fig. 3 the mold is shown closed, ready to be poured. In Fig. 4 it is shown open, the cores having been withdrawn and the casting removed. In Fig. 5 the cores are shown in position for the next pouring, it only being necessary to close the mold before making a new casting. The block bolted to the base of the machine supports the hinged half of the mold when it is in its closed position. The metal in this casting is ¼ inch thick. Its shape requires that the cores be withdrawn one from each end. The metal is poured, the cores withdrawn, the mold opened, and the casting removed, as fast as the operator can work. The time elapsing from the beginning of the pouring until the finished casting is removed in this case is about eight seconds. It will be noted that the metal enters into the mold from the gate by means of two channels, this being done because it has not proved successful to permit the molten metal to strike and pass by the joint of the cores as it must do if supplied from one channel only. There is no special locking device for holding the two halves of the molds together. In the case of small molds like the one here illustrated, the weight of the mold itself is enough to prevent opening up when the metal is poured.

In Figs. 6 and 7 is shown a mold for casting a mining car wheel 16 inches in diameter, and having a section of ⅞ inch; this wheel weighs about one hundred pounds. The tread is chilled, but the center is soft. This is accomplished by first removing the core by means of the center lever to the left, within about two seconds of the pouring of the metal; then the lever at the right is operated, withdrawing the large plug, shown in Fig. 7, which forms the spokes in the wheel. This removes any chilling influence from the center of the wheel, but the outside or tread part remains in the mold for about six to eight seconds longer, at which time the plug in the right-hand half of the mold is moved forward again, throwing the casting out of the mold. The whole cycle of operations requires 40 seconds.

In the case of a big mold of this type it is necessary to hold it together while pouring. The two parts of the mold are held together by means of a bent rod or hook, as shown on the side of the mold in Fig. 6. It will be seen that this method of holding the two halves of the mold together permits of a slight expansion, which is absolutely necessary on account of the expansion of the parts due to the heat.

In Fig. 8 is shown a large mold for making a ten-inch extra-heavy pipe flange, 17 inches outside diameter and 2¾ inches thick, this casting weighing about 130 pounds. As soon as the casting is poured, the large center core is withdrawn, and then the mold thrown open. The casting is then removed by pushing the center plug or core in again, which forces it out, the same as in the case of the mining car wheel. When taking out the casting a hook is used for lifting it out and laying it on the floor. The two halves of the mold are held together by a bent hook or rod, the same as in the pre-

vious case. The leverage arrangement used to the left in Fig. 8 for withdrawing the core is of special interest. The levers are so arranged that considerable power and very little motion results when the lever is first pulled backward towards the operator. This is necessary in order to provide for the power that is required for starting to remove the core from the casting. Then, as the lever gradually descends to a horizontal position, the rapidity with which the core can be moved out is greater, as may be seen from the illustration.

The strength and the bulk of metal in the molds are the two main features to be taken into account in designing these machines, and they must be arranged so that they can be easily manipulated. In the case of the heavier molds it will be seen that the movable half of the mold is mounted on small wheels. In Figs. 3, 4 and 5 is shown how an extension lever is applied so as not to necessitate having so long a lever provided for every one of the molds in a battery.

If the mold should rust, the first few castings do not come out very well, the rust causing air holes. The casting process, however, is carried right on, and after a few castings have been made the difficulty will be overcome. For this reason the first castings in a new mold that has been shipped for some distance are often not satisfactory, because there is likely to be more or less rust formed in the mold in spite of the precautions that have been taken to prevent it. In the mold shown, castings are made having a thickness of from ¼ inch up to 2¾ inches. This gives a good idea of the range and possibilities of this process for castings of various types.

In Fig. 9 is shown a line engraving of the mold illustrated in Fig. 8. The part constituting the mold itself is shown in section, and the action of the device is clearly indicated. The plunger *A* is the core, *B* is the stationary, and *C* the movable part of the mold. The actual construction of the lever arrangement to the left, previously referred to, is also clearly indicated. Ample clearance is left in the mold *C* for the end of the core, and a hole *D* is provided for letting out the air in front of the core.

In Fig. 10 is shown a section of a mold for a 6-inch flanged extra heavy T; this mold is not shown in the half-tones. In this case three cores are used, one entering from the top, one from the bottom, and one from the side. The top and bottom cores are operated by the same lever, and the side core by an independent lever. The mold is then opened by a separate lever system, pulling the molds apart in a direction towards the observer in Fig. 10. The T cast in this mold weighs about 200 pounds. The molds shown in Figs. 9 and 10 were made for the Tacony Iron Co. by the Morris Engineering Co., Philadelphia, Pa., and the engravings are reproduced from drawings furnished by this company.

* * *

A convenient tool indexing system is used by the Acme Machine Tool Co., Cincinnati, Ohio. The tools, jigs and fixtures used in the manufacture of the company's product are placed on shelves, each tool being numbered separately. The numbers of the tools to be used for any particular piece of work are marked directly on the drawing of that piece, so that when the workman is given the drawing, he also knows immediately what tools to call for from the tool-room in order to complete the work in hand. This has been found a very convenient system. It saves a great deal of clerical work and eliminates mistakes. If the tools used for making any given pieces should be changed, it is a small matter to change the number on the tracing and make a new blueprint, or to change it directly on the blueprint, if desired.

* * *

Foreign users and builders of machinery seem to be much more particular about the proper location and cutting of oilways than they are in America. So little attention is given to this important detail here that there is no general-purpose oilway cutting machine on the market that meets with the approval of foreign manufacturers. We infer that a simple, low-priced machine adaptable to grooving large and small cylindrical bearings, either axially or helically, and also flat ways, would meet with considerable sale.

SYSTEM, EASY MONEY AND HONESTY

By A. TRAVELER

"The big plant of the Titan Engine Co. over there seems to be running pretty quiet now."

"Yes," said the Man Waiting for a Car, "they are practically down and out. The engine and boiler business has gone completely to smash. They are working now mostly on auto parts."

"What's the matter—thought the company was one of the biggest and strongest in the world?"

"It was and so it would be still if they'd let old Nat Greene, the superintendent, alone. You see he was a bit old-fashioned, and when the company became rich a number of youngbloods were brought in who thought they must have up-to-date methods and management. What did they do? Well, it's a rather long story, but I guess I'll have time to tell it—these cars run on a go-as-you-please schedule and the next one may not be along for ten minutes yet.

"In the first place the president, Hugh Bishop you know, had to go to Florida two years ago for his health. He was so bad off that he had to give up everything. He left the secretary in charge, and say! he and his clique didn't do a thing to the business. About the first shot out of the box was hiring one of them systematizers from Erie, to modernize the plant. This fellow put in what they called a premium system. I don't know just how it was supposed to work, but it worked out here to be a premium on dishonesty. Those boiler-makers pitched right in, and the way they turned out boilers was a caution to cats. Some of them made $8 a day right along, and they turned out boilers so fast that the company couldn't get cars enough to take them away.

"In the office things was just humming, too. The systematizer put in the most wonderful accounting system you ever heard of. He could tell to the tenth of a cent at any minute day or night what a governor ball cost, and could show you what it cost last month, the month before and so on *ad infinitum*. Gee! it was great! You ought to have seen the clerks —one hundred and fifty-seven of 'em—working away like mad tabulating statistics, filing cards, making out reports and other forms too numerous to mention.

"Old Nat Greene was just about crazy. He didn't know what to do or what his place in the new system was, but he knew things were going bad. All the men were eaten up with the idea of making big money and the systematizer and his crew was just pushing 'em along. 'Twas a good thing that Nat up and died from worry when he did for they'd have 'dumped' him anyway, and that would have broken his heart.

"After they had been working the new system for about six months the men didn't like things so well; the premium rates were changed and you can bet they weren't changed for the better. It was cut and-cover then to keep up their pay anywhere near what it was before. You see the scheme was about like this. The head ones in the system were given big bonuses to secure a certain production and they took the profit out of the men.

"Well, about this time those boilers built under the new system began to give trouble. When they were set up in the power plants and fired up some of them leaked at every joint. It was terrible. Fifty of the best men had to go out on the road to fix up botched work, and then some of the boilers wouldn't stay sold! You can see a lot of 'em right over there now.

"But the boilers weren't any trouble at all compared to the engines. Along with all the other changes, they'd designed a new engine that was going to be a world beater, and they were so confident that they went right ahead and took contracts from nearly everyone in sight, putting up power plants. You ought to have seen some of the guarantees—they certainly did read fine. They say there is over a million dollars worth of them engines waiting to be hauled out and sold for scrap. They're absolutely no good.

"Well, after all these troubles things got real interesting in financial ways and the bankers took a hand in the business. The president got wind of the trouble and came hustling home

sicker than ever, I can tell you when he found out how things were, but it was a case of take the helm or go to smash entirely. Some of the items he found on the books about the City Hall boilers and bribing the city fathers he told about right out in Sunday school, and they sure did make a sensation. Two of the head men skipped out and went to Europe and several others resigned in a hurry."

"You don't think the system was to blame, do you?"

"Well, perhaps not, but it seemed to make everybody crazy for easy money and when men get after that, honesty and morality seem to sort o' fade away. Hello, here comes my car at last. Goodby."

* * *

LUMINATOR TREATMENT OF WATER

A very novel treatment of water, the invention of a German scientist, Herr Brandes, is being promoted in this country by the Luminator Water Co., 24 Cedar St., New York, this company holding the American patents.

This treatment of water for the prevention of scale in boilers without the use of chemicals consists in simply allowing water to run down an aluminum plate of special dimensions, with corrugations of a particular size, according

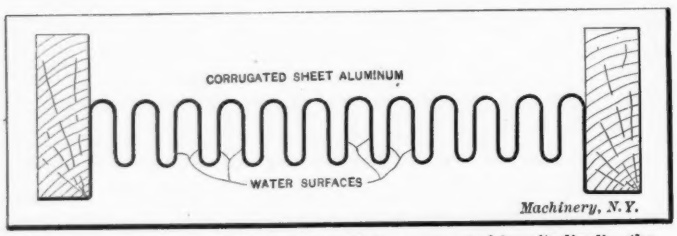

Fig. 1. Cross-section of a Luminator Plate, corrugated longitudinally, the Water to be treated passing down in the Corrugations

to the character of the water to be treated. The cross-section of one of these luminators is illustrated in Fig. 1, and a typical installation of a battery applied to softening water for railway service is shown in Fig. 2, which represents an installation on the Philadelphia & Reading Railway.

As shown in Fig. 1, the water passes down corrugated surfaces, inclined at a slight angle to the vertical; the corrugations present a large surface of contact between the aluminum and the water. No chemicals are required, it only being neces-

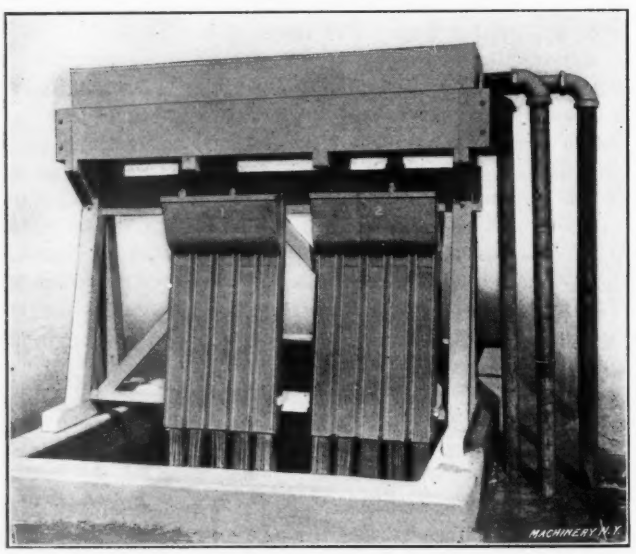

Fig. 2. Installation of a Battery of Luminators on the Philadelphia and Reading Railway

sary to brush off the corrugations at more or less frequent intervals, in order to clean and free them from deposit.

The discovery of the luminator was somewhat of an accident, and the phenomena accompanying its operation have been explained as follows: The passage of the water over the metal channels at certain speeds induces a very slight current of electricity, the water being negative and the plates positive. This causes the salts to ionize, and instead of taking a crystalline form they become amorphous; at the same time a new and particular action goes on, for the aluminum, by friction and electrical action, is abraded from the surface as a colloid, which after a period undergoes changes in the water.

Another remarkable feature of the luminator is that the best results are obtained when it is facing either north or south and exposed to direct light. The north and south direction is explained by the fact that when in this position the lines of force of the earth's magnetism are cut at right angles by the passing water, thereby inducing a small E. M. F., with the result that a slight electrolysis occurs, precipitating aluminum hydroxide in the solution. The presence of light is necessary to polarize the salts in the solution.

The action of water thus treated within a steam generator is somewhat obscure, but it is thought that the colloidal aluminum acts as centers for the evolution of carbon dioxide and the crystallization of salts; also the aluminum particles will combine with the dissolved oxygen of the water causing a marked de-oxygenation.

* * *

BARBERS' CLIPPERS NOT MACHINE TOOLS

The following United States Customs rulings made March 29 and reported in the New York *Times* are of considerable interest to those who are endeavoring to formulate a concise and comprehensive definition of the term "machine tool."

The Board of United States General Appraisers decided that hair-clipping instruments used by barbers for cutting hair are not "machine tools" within the meaning of the Tariff Act of 1909. The merchandise in controversy was entered by Sears, Roebuck & Co., of Chicago. The Custom House authorities classified the articles as "manufactures of metal" and imposed a duty of 45 per cent. Under the claim made by the importers the duty would be 30 per cent. The written decision of the board states that the tribunal is not satisfied that the articles under consideration are machine tools, it being maintained that the hair-clipper is an instrument of manual operation and would answer in that respect to the definition of a "tool." At the same time the board takes the view that the article in no way partakes of the character of power tools and is not within any of the definitions of the term "machine tools" as given by the lexicographers. The importer's claims were accordingly overruled.

Another claim involving the aforesaid tariff paragraph for machine tools was filed by the American Steel & Wire Co. The Collector of Customs at Cleveland assessed a 45 per cent duty on cast-steel rolls for rolling mills, on the ground that the rolls are for "manufactures of metal." It appears from the testimony that the articles are merely hardened cast-steel tools. The decision of the board states that while the articles may be parts of machine tools, they are not entitled to classification under the provision for machine tools. On this point the decision reads:

"The cold rolling mills of which these rolls are to form a part would, if imported, be subject to the classification at the rate claimed, but the steel rolls considered separately would no more be entitled to such consideration than would the gear wheels if imported alone. The protest is overruled and the decision of the collector affirmed."

* * *

TO MILL LONG NARROW SLOTS ACCURATELY

A valuable wrinkle worth remembering when milling long narrow slots in steel is that the feed should be in the same direction as the cut if absolutely straight slots are required. The reason is that thin slotting saws or cutters, which are very limber and easily sprung sideways, "track with the slot" when the feed is with the cut. The teeth strike into the metal fairly and there is no tendency to run. If the feed is against the cut a hard spot in the steel is likely to throw the cutter over to one side, and the teeth begin to run out of line. The portion of the slot already cut tends to guide them farther and farther away from the line of the slot, the result often being that the teeth are broken off. Feeding with the cut means a straight slot; feeding against the cut often means a spoiled cutter and a spoiled job.

LETTERS ON PRACTICAL SUBJECTS

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A STAMPING PUNCH AND DIE

Among the numerous articles manufactured by Adolph Muehlmatt, Cincinnati, Ohio, are screw backs for lapel buttons of different kinds. These button backs are made of two pieces of sheet brass, the inner one being held in place by the edges of the outer disk which are cup-rolled over it in a punch press. Many of these button backs are stamped with the name of the purchasing firm when ordered in a sufficiently large quantity, the stamping being done immediately after the blanking operation.

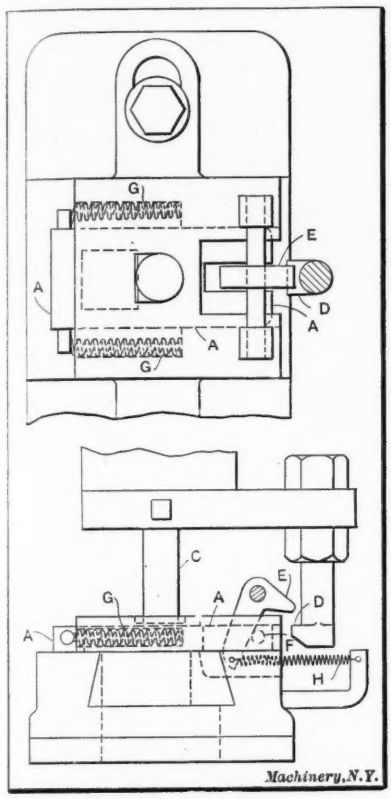


Fig. 1. Plan and Side Elevation of the Stamping Punch and Die

As the time taken to place and remove these disks from a common hollow stamping anvil-die was too great for economical production, the mechanism shown in the illustrations was designed to automatically drop the stamp disks as the press arose. By some, a disk feed might be preferred, but save for a little greater safety in operation, the mechanism shown has every advantage over the disk feed, when only a few thousand are to be run through at a time; nor is the factor of safety low, for as the stamping punch is considerably smaller than the disk, and also because of the squared outer corners of the plate, a sufficient margin is left for the fingers to drop the disks into place. Figs. 1 and 2 clearly show the construction of this mechanism, while Fig. 3 shows it in place in the punch press.

In Fig. 2, the anvil block *A* is shown partly drawn back, that its action may be more clearly illustrated. The anvil slide is made of machine steel with a piece of hardened tool steel *B* set into it directly in line with the stamping punch *C*. It is operated by the finger *D* pulling up on the hook *E*

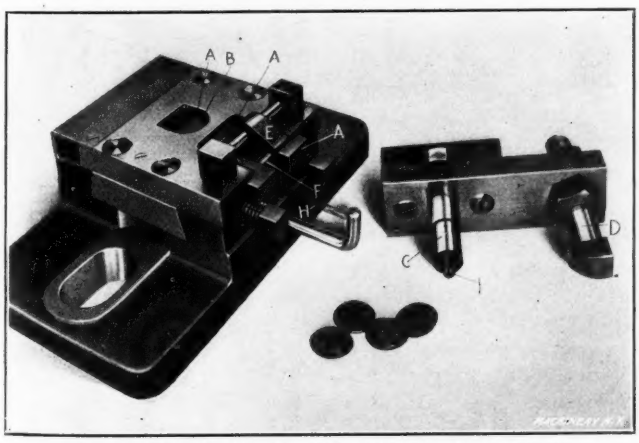


Fig. 2. Stamping Punch and Die with Samples of Work

as the ram rises, which causes it to push out on the pin *F*, drawing out the slide and thereby letting the stamped brass disk drop down through the bed plate into a box below. The continued upward movement of the ram releases the hook *E* from the finger *D* and the anvil flies back into place propelled by the springs *G*. The spring *H* is used to cause the hook *E* to catch promptly, as gravity alone will not bring it back with sufficient rapidity. Plunger *I* in the end of the punch *C* is a

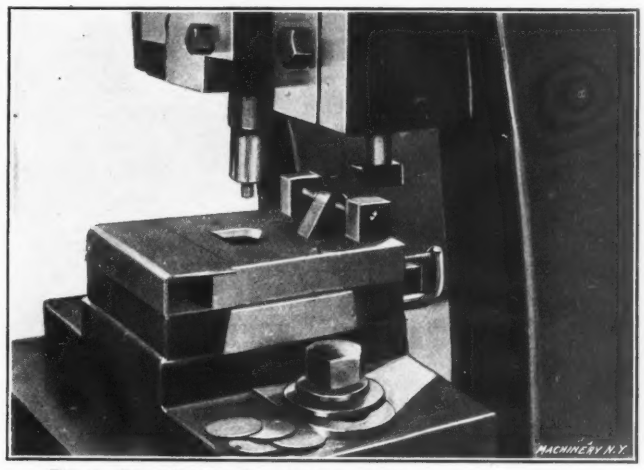


Fig. 3. Stamping Punch and Die in Position on the Punch Press

knock-out to prevent the punched disk from sticking to the lettering as the punch rises.

E. V.

SQUARE-THREADED TAPS

The making of taps which will cut a good square thread in a nut is a very difficult proposition, and, in fact, it has been found almost impossible to cut what might be called a perfect thread in a nut with a square-threaded tap. The usual way, and, undoubtedly, the best method of cutting threads of this kind is to use a set of taps, usually three or more, each one of these taps being passed through the nut successively. The taps should all be provided with a pilot at the end, as shown in the accompanying illustration Fig. 1. This tends to guide the tap straight, and improves its cutting qualities

Fig. 1. Set of Three Taps with Square Threads

in general. The diameter of the pilot on each succeeding tap should be about 0.005 inch smaller than the full diameter on the top of the thread of the straight portion of the preceding tap. It is advisable to provide the first tap in a set with a left-hand spiral flute, to make it cut more freely. In Fig. 1 a tap having eight square threads per inch, 9/16 inch in diameter, is shown, and the proper proportions for a set of three taps of this diameter and number of threads are indicated.

When it is required to thread only a comparatively few nuts, it is possible, however, to do the work with but one tap, made as indicated in Fig. 2. When the tap is made in the manner indicated, as good a thread wll result as if a set of taps were used, but, of course, the tap does not cut as freely and easily, owing to the fact that it removes considerably more metal in a shorter space of time, and with a smaller number of cutting edges. In this case the threads of the tap

are chamfered on the top as usual, down to a few thousandths of an inch over the root diameter of the thread. The reason for not chamfering the threads on the top fully down to the root diameter is to make it possible for the tap to "take hold" immediately in a plain hole. The tap is also tapered in the bottom of the thread for about one or one and one-half inch from the end of the threaded portion, and afterwards the square corners of the thread are removed by a 60-degree V-tool, having a flat equal to the flat at the bottom of the square thread. When chamfering the square corners of the

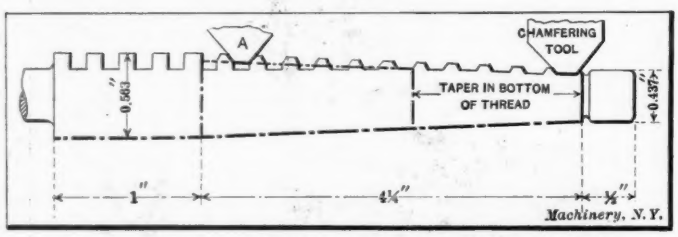


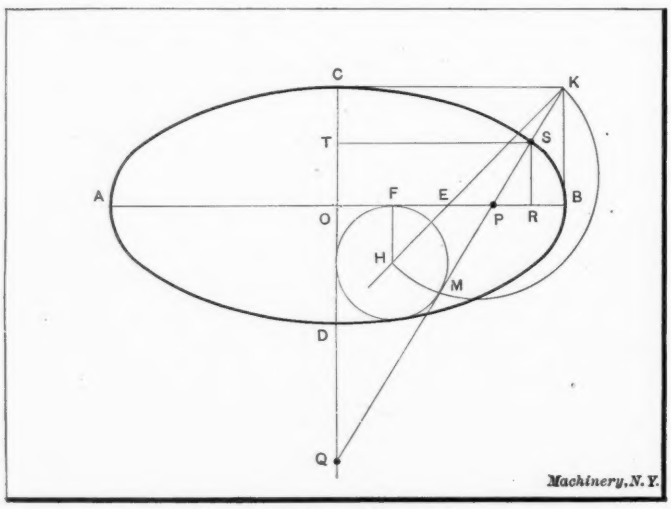
Fig. 2. Single Tap designed to perform the same Work as the Three Taps in Fig. 1

threads with this tool, the taper attachment should be so set that while the tool enters clear to the bottom of the thread at the entering end of the tap, it gradually recedes so that at the upper end of the chamfered portion of the thread it does not enter any deeper from the top of the thread than it does at the beginning of the cut. This is indicated at *A* in the illustration. Taps made by this method have given satisfaction, and as one tap made in this way is considerably cheaper than a set of three taps made as outlined in Fig. 1, a considerable saving results in cases where only a comparatively few holes are to be tapped. CORRESPONDENT

"A NEW CIRCULAR-ARC ELLIPSE CONSTRUCTION"

The article entitled, "A New Circular-Arc Ellipse Construction," which appeared in the March number of MACHINERY, engineering edition, interested the writer to such an extent that he investigated the subject still further, the results of his investigation being embodied in this article.

In the illustration *AB* and *CD* are the major and minor axes of an ellipse, equal to $2a$ and $2b$, respectively. On *AB*, lay off *BE* equal to *OC;* and bisect *OE* at *F*, erecting the per-



Circular-arc Ellipse Construction

pendicular *FH*. Draw *CK* and *BK*, respectively parallel to *AB* and *CD*, and join *KE*, producing it to cut *FH* at *H*. With center *H* and radius equal to one-half *OE*, draw the circle *FM;* also draw the semicircle *HMK* on diameter *HK*, and through the point of intersection of these two circles, draw the line *KPMQ*, cutting *AB* at *P*, and *CD* produced at *Q*. *P* and *Q* will then be the centers of the component circular arcs, having common tangents at *S*.

For the proof, the problem will be divided into two parts; the first part considering the condition to be fulfilled when the two arcs *BS* and *CS* shall have tangents in common with the ellipse at *B* and *C*, and also have a common tangent at *S*. From the similarity of the triangles *EBK* and *EFH*, and also as *BK* equals *BE*, *FH* equals *FE*. But *FE* is equal to $\frac{OB-OC}{2}=\frac{a-b}{2}$; therefore $FH=\frac{a-b}{2}$, which makes the radius of this circle dependent only on the axes, so that the only condition for these three points being in the same line is that this line be tangent to the circle of radius $\frac{a-b}{2}$. Also the line that bisects and is perpendicular to the chord *BS*, must bisect the angle *OPQ* and contain *P;* and similarly the bisecting perpendicular to the chord *CS* contains *Q*. The intersection of these two lines would be at *H*, which must be the center of the inscribed circle in triangle *OPQ*.

The second part of the problem is to locate point *S* so that the compound curve will approach as nearly as possible to that of the ellipse. For the matter of proof, consider that the point *S* is contained in the ellipse. Let *SQ* and *SP* be represented by *R* and *r* respectively. In the triangle *OPQ*, $\overline{QP}^2=\overline{OP}^2+\overline{QO}^2$

$$(R-r)^2=(a-r)^2+(R-b)^2$$

Hence

$$2\,(R\,b+r\,a)=a^2+b^2+2\,R\,r \qquad (1)$$

The triangles *STQ*, *SRP* and *OPQ* are similar; therefore

$$x=\frac{a-r}{R-r} \text{ and } y=\frac{(R-b)\,r}{R-r}$$

When the ellipse contains *S*, the equation to the ellipse must hold good at that point; or

$$\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$$

Substituting the above values of x and y in this equation gives

$$(a^2+b^2)\,R\,r+2\,a^2\,b^2=2\,a\,b\,(R\,b+r\,a)$$

which by introducing the value of $Rb+Ra$ above, reduces to

$$Rr=ab \qquad (2)$$

The condition to be fulfilled when the meeting of the two arcs is a point of the ellipse will therefore be that the line containing the two centers cuts the axis in points *P* and *Q* so that *PB* and b are inversely proportionate to *QC* and a. This will occur when the tangent *PMQ* passes through *K*.

By solving Equations (1) and (2) the values of the radii are deduced as follows:

$$R=\frac{(a+b)^2+(a-b)\sqrt{a^2+b^2+6\,a\,b}}{4\,b}$$

and

$$r=\frac{(a+b)^2+(a-b)\sqrt{a^2+b^2+6\,a\,b}}{4\,a}$$

In practice, this construction may be simply done in the following manner: When the lines *CK* and *BK* are drawn, draw lines through *O* and *K*, forming an angle of 45 degrees with *AB*. With their point of intersection as a center and the distance to one of the axes as radius, draw an arc at *M*. Drawing a tangent to this arc at *M* from the point *K* locates the two centers *P* and *Q*. J. H. V. BRAMMER

Duquesne, Pa.

USE OF RUBBER STAMPS ON TRACINGS

The accompanying description is of a method which has been successfully used by the writer for over five years for the purpose of stamping tracing linen. Any kind of rubber stamp that is made for use on flat surfaces is applicable, for success lies merely in the way the ink is applied.

The method is as follows: Take some "Original Nubian Black," No. 6729 printing ink, which may be obtained in very small cans, and put a very small portion on a piece of plate glass; about one-quarter the amount that can be put on a dime will be sufficient. Spread this small amount of ink with hand roller, such as are furnished with small name card printing presses. Continue this process until the ink is of an even thickness all over the roller; the latter should

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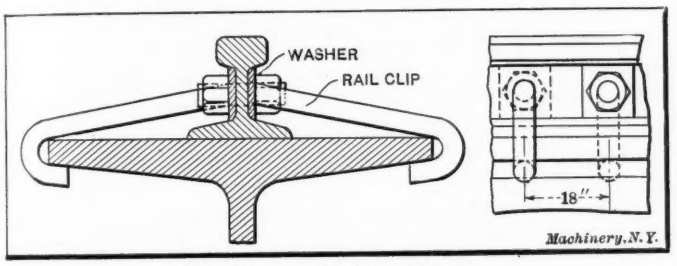
then be run over the face of the stamp until the types are evenly covered with ink. An impression can now be made with the stamp. After doing this, take a can of cheap commercial talcum powder and sprinkle a very small quantity over the impression, spreading it lightly with a cloth. Dust off all the surplus that is not absorbed by the ink; this dries up the damp surface and keeps it from blurring. It can now be used for making blueprints and there will be no danger of the ink smearing if it has not been put on too thickly. This latter can be best determined experimentally.

This ink is a very deep black, but is soluble in gasoline; and consequently, if an unsatisfactory impression is made on the tracing cloth, it may be easily washed off. In the use of this process, it is advisable also that all ink be washed off the stamps and roller before putting away. The glass plate, however, need only be washed off once a week, or as often as experience dictates, provided however, that it is kept from the air and dust while not in use. W. G. W.

RAIL FASTENINGS FOR CRANE RUNWAYS

When designing a shop that is to have runways for overhead cranes, the use of Bethlehem beams or I-beams will be found practical. Up to the present time, Bethlehem beams have not been used to any great extent for this purpose on account of the great cost of making holes in the flanges for



Rail Fastening for Crane Runway

bolting or riveting on the rail. These holes would have to be drilled, as the flanges are too thick for punching. By using a clip such as shown in the accompanying sketch, a Bethlehem beam can be used, and punching or drilling done away with. For a 40-pound or heavier rail, it would be advisable to use ¾-inch round iron for the clips and place them at 18-inch alternate spaces. A washer can be put under the nut of the clip to make a flat bearing surface on which the nut can turn. By loosening one clip and tightening the opposite one, the rails can be straightened or adjusted to the proper gage. EDWIN J. KNAPP

Cleveland, Ohio.

TAPPING A LEFT-HAND THREAD WITH A RIGHT-HAND TAP

One of the men in the shop performed a little kink a short time ago which was so novel to the rest of us that the writer thought it was worthy of further publicity.

A ⅜-16 left-hand tapped hole had to be made in a piece of work and as there were no ⅜-inch left-hand taps in the shop, and also as the swinging of the piece on the lathe was out of the question because of the bulkiness of the work, some

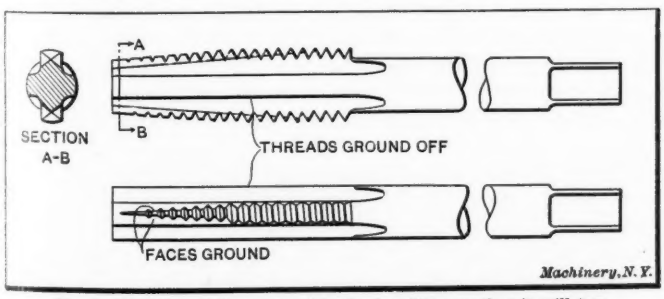


Fig. 1. Right-hand Tap ground in Such a Manner that it will tap a Left-hand Thread

means of doing the job had to be improvised. This was accomplished by taking a ⅜-16 right-hand starting tap and treating it as shown in Fig. 1. Two of the opposite lands had their threads completely ground off and the edges of the two remaining lands were so ground towards the point as to leave just a narrow section of thread. This narrow section of thread, therefore, conformed quite closely to that of a similar section in the left-hand tap.

In tapping the hole, the tap was entered gradually by turning it to the left, as little pressure as possible being exerted, thereby preventing the tap from reaming or cross threading. The tapped hole showed a clean thread which satisfactorily answered the purpose for which it was intended.

CHAS. DOESCHER

Waterbury, Conn.

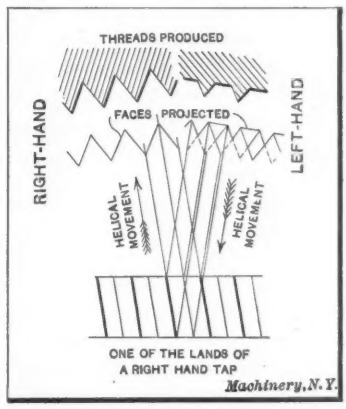
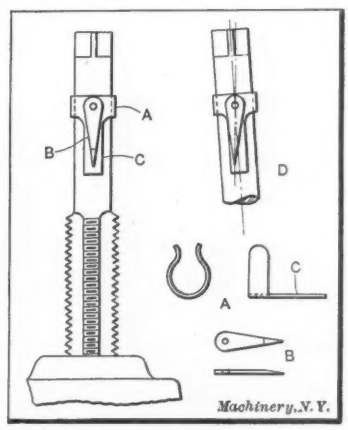


Fig. 2. Diagrammatic Representation of the Cutting of a Left-hand Thread with a Right-hand Tap

[As might be inferred from the method of tapping, the thread produced will not be perfect. The reason for this is graphically shown in Fig. 2, which is a somewhat exaggerated representation of one of the lands of a right-hand tap. In cutting in its normal manner, *i. e.*, cutting a right-hand thread, the helical movement will be as shown. The projection of the teeth on a surface normal to the helical direction is the same as the cross-section of the teeth, and therefore a perfect thread is produced, all as represented on the left side of the illustration. On the other hand, if the same tap be used to cut a left-hand thread, the helical movement will be around a helix ascending in an opposite direction. The projection of the right-hand teeth of the tap on a plane normal to this left-hand helical direction will be as shown. The face of the teeth will cut a perfect thread but the rear portion of the land, being helical in a different direction, will drag, making the bottom of the thread flat and scraping the side off of the adjoining teeth, which condition is represented in the upper right-hand corner of the illustration. However, for the purpose for which it is intended it seems to have given satisfaction. A sample cast-iron nut sent for inspection with the tap, showed a very nearly perfect thread, having the general characteristics of the U. S. standard; for, while theoretically it should not flatten at the top of the thread, it apparently has done so, though to nothing like the exaggerated extent represented in Fig. 2 for the thread bottoms.—EDITOR.]

A TAP PLUMB

The accompanying illustration shows a simple device for use when tapping holes in work which has previously been leveled, and on which it is impossible to use an ordinary square for determining whether the tap is going in square or not. This device consists mainly of a band *A*, which is bent into a circular shape to fit the shank of the tap. A pointer *B* is riveted to this band, but is allowed to swing freely, so that it can register whether the tap is going in square or not. An index line is scribed on the projection *C* of the band *A*, and when the pointer registers with this line the tap is in a perpendicular position in one plane. Of course this device cannot indicate when the tap is out of plumb on the side to which the pointer is attached, as is shown clearly at *D* where the tap is slightly inclined to the left, but it can be turned to any position. The band is made from sheet steel and tempered, and the pointer is also made from sheet steel, but not tempered. J. E. C.



Application and Details of Tap Plumb

A FRICTION CLUTCH

The accompanying illustration shows a friction clutch designed by the writer for starting, stopping or reversing. This clutch was made for a drilling machine and it will easily transmit the power delivered by a 3-inch belt, running on a 14-inch pulley, at any speed up to 500 or 600 revolutions per minute.

In the particular machine for which this clutch was designed, the clutch-shaft was entirely independent of the rest of the machine (being coupled to the clutch body), so that to save machining the shaft was cast integral with the clutch body, as shown in Fig. 1.

The friction rings were first made of mild steel, but we found that cast iron was preferable. It may also be interesting to know that the 42 by 6 pitch miter gears by which the clutch was driven were also made of cast iron.

The levers which expand the rings are of tool steel, hardened at the wearing end, this hardened end pressing against the hardened tool-steel pads which are dovetailed into the rings. Fixed on the inside of the sliding collar *A* is a hardened tool-steel cam or wedge *B*, which provides the necessary movement to the levers, through small screws having rounded ends, these screws being checked by locking-nuts. The cam, or at least the working face of it, forms part of a circle so that the motion of the levers is a harmonic one; that is, the leverage increases as the friction rings begin to take hold. This is required to prevent the clutch from slipping, and also to keep it from working out of engagement by vibration.

Another detail (not shown in the illustration) is the milling of, say, a dozen grooves about 1-4-inch wide and 1-16 inch deep, across the face of the rings. This increases the pulling power of the clutches considerably.

RACQUET

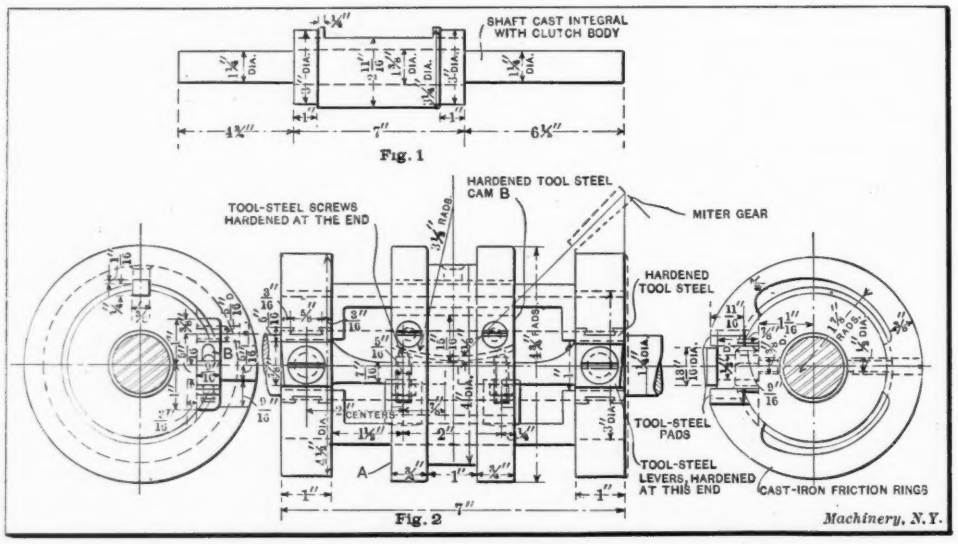


Fig. 1. Detail of Shaft and Clutch Body. Fig. 2. Assembled View showing how Clutch is operated

CUTTING A MULTIPLE-PITCH WORM

Being particularly interested in the cutting of multiple-threaded screws in the lathe, the writer would like to add a further contribution to what has already appeared in the November and February issues of MACHINERY under the heading of "Cutting a Multiple-Pitch Worm."

Both contributors have given a rule whereby, under certain conditions, the lead-screw of the lathe may be employed for the purpose of dividing the lead of the worm being cut; but in neither of the two articles has any reference been made to the pitch of the lead-screw, and as this is one of the chief factors in problems of this kind, the rules which have been quoted must be considered as incomplete.

Now in all cases the pitch of the worm (lead of the worm ÷ number of threads) and that of the lead-screw bear a definite relation to each other; and if it is desired to use the lead-screw for the purpose of spacing the threads, then, generally speaking, either one or the other of the following conditions must be satisfied: (a) The pitch of the worm must be equal to, or a multiple of, the pitch of the lead-screw; or (b) In the case of fractional pitches, the distance represented by the least common multiple of the pitch of the lead-screw and the product of the pitch of the worm and a whole number—either one more or one less than the number of threads in the lead of the worm—must not be a multiple of the lead of the worm. In all other cases, the required division must be obtained, either by "chalking the change gears," or using some one of the different methods described in MACHINERY'S Reference and Data Sheet Series.

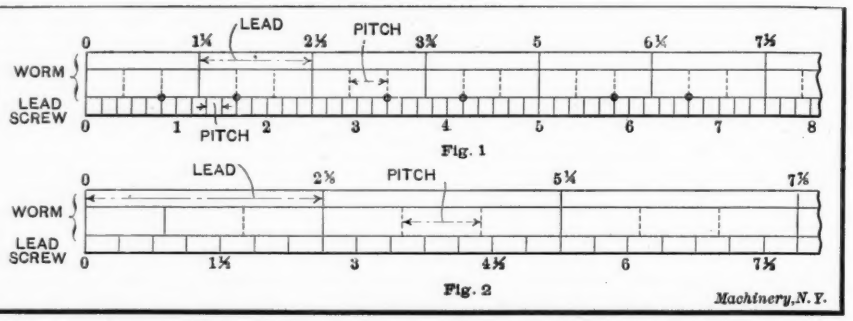


Fig. 1. Cutting a Triple-thread Worm having a 1 1/4-inch Lead with a 6-pitch Lead-screw. Fig. 2. Impossible Conditions of Cutting a Triple-thread Worm having a 2 5/8-inch Lead, with a Lead-screw having a 3/8-inch Lead

Multiple-threaded screws which satisfy (a) will also satisfy (b), and present no serious difficulty when cutting; but those screws which meet the requirements of (b) only, are more troublesome to deal with. The following example quoted by O. G. will be worked out: The lead of the worm is given as 1¼ inch and it is triple threaded; therefore the pitch is equal to $\frac{1\frac{1}{4}}{3}$ or $\frac{5}{12}$ inch. As the pitch of the lead-screw is not given, assume it to have six threads per inch or a 1/6-inch pitch (a reasonable assumption for American practice) so that from (b) it is required to find the least common multiple of $\frac{5}{12} \times 2$ and $\frac{1}{6}$ which is equal to $\frac{5 \times 1}{6} = \frac{5}{6}$ inch.

This distance of 5/6 inch not being a multiple of 1¼ inch (the lead of the worm), the division of the lead may be obtained from the lead-screw from rule (b) as follows: After taking the first cut and stopping the lathe, the screw-cutting stop must be set a distance from the end of the saddle equal to 5/6 inch multiplied by any whole number such that the product is not a multiple of the lead of the worm. This distance depends, of course, on the length of the worm, as for example, if the length of the worm were 3 inches, then the stop would be set back a distance of $\frac{5}{6} \times 4 = 3\ 1/3$ inches where it will be found that the clasp-nut will gear in, and when the lathe is again started a second thread would be formed, and so on until the worm is completed. This will be readily seen from a reference to Fig. 1, which consists of two scales, the lower representing the threads of the lead-screw, and the upper, those of the worm; the lead of the worm is shown by full and the pitch by dotted lines.

State University of Iowa 5 MAY 1911

As the distance the saddle may be moved for the clasp-nut to engage is always equal to a complete number of the threads of the lead-screw, if the tool is to generate a second thread the scales must coincide at some other points besides those of the lead of the worm; otherwise, the division is impossible, as in Fig. 2.

In Fig. 1 the threads coincide every 5/6 inch, and it is obvious that after the first thread has been generated if the clasp-nut were engaged at any of the circled points, the lead would be divided as required. These distances, measured from the zero of the scale, correspond to the results obtained from working out the example.

Consider next the worm example given by S. H. C. Here the length of the worm is 4½ inches, lead 2⅝ inches, and it is triple threaded. Assuming that the pitch of the lead-screw is ⅜ inch (frequently the case in English lathes), it is necessary to find the lowest common multiple of $\frac{2\frac{5}{8}}{3} \times 2$ and $\frac{3}{8}$, which is $\frac{14 \times 3}{8} = \frac{42}{8} = 5\frac{1}{4}$ inches. But 5¼ inches is twice the lead of the worm; in other words, it is a multiple and does not satisfy the conditions of (b), so that the division in this case is impossible, as may readily be seen by referring to Fig. 2. It will be noticed that by taking other pitches for the lead-screws the rules obtained by S. H. C. and O. G. will be reversed, showing the need for the more explicit statements given in (a) and (b).

While in no way detracting from the truth of the above statements, it may be observed that when the lowest common multiple obtained is great in comparison to the length of the screw, it is a questionable policy to adopt this method, as probably more time would be taken in traveling over this distance than would be by adopting other methods.

Belfast, Ireland. G. H. LONGWORTH

ORGANIZING A DRILLING DEPARTMENT

How to make the drill gang pay, was for a long time a big question in our shop. High-priced men were found to be accurate, careful mechanics, but much too slow, spending altogether too much time grinding their drills to standard plug when they were to be used for such purposes as clearance bolt holes, etc. Low-priced men were equally unsatisfactory for the opposite reason; but the real difficulties occurred when an attempt was made to mix the two kinds of mechanics.

After many trials the drill gang was arranged as shown in Fig. 1, and has given very satisfactory service, no trouble

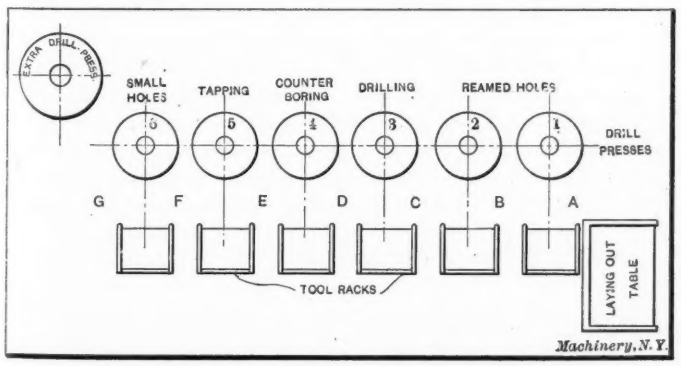


Fig. 1. Manner of Arranging Drill Presses to expedite Work

being experienced from the different qualities of labor. The gang is what the "old man" calls "self-driven," and everyone is satisfied. In this arrangement there are six drill presses with accompanying tool-stands or tables, an extra drill press and the laying-out table, as Fig. 1 shows. Numbers 1 2, 3, 4, etc., designate the machines in their order of importance, the most important being nearer the laying-out table so that any information may be obtained from the "layer-out." The better mechanics are placed at this end, grading down to the less skillful ones on the farther machines. This arrangement gives the operators of the lower-priced machines an incentive to work up, as the better job is always just ahead.

To consider the system in operation, the production of a sample piece, such as is shown in Fig. 2, might be followed through. Suppose ten of these pieces are to be produced. The pieces are brought, in a rough state, and placed upon the laying-out table where they are laid out, and dropped on the floor at *A*, the drawing being tossed over onto the tool rack in front, where the first drill-press hand has an opportunity to examine it. The operator on the first drill has instructions to drill all holes which are 1¾ inch and over. He sets up, drills, and reams the 2 1/16-inch hole shown, and throws the piece down at *B*. Number 2 being instructed to drill all holes which are 1¾ inch and under, sets up, drills and reams the 1½-inch hole shown, dropping the piece at *C*;

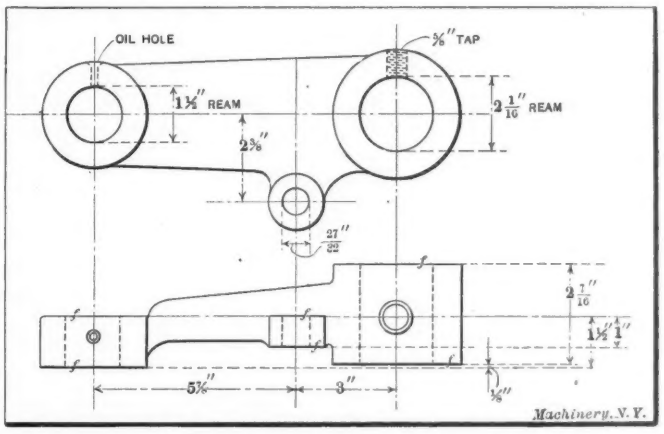


Fig. 2. Sample of Work serving to illustrate the Operation of the System

Number 3 drills the 27/32-inch hole, dropping the piece at *D*. Number 4 places it on the counterboring block and faces the two large bosses, omitting the small boss, and then drops it at *E*. Number 5 clamps it to an angle-plate and taps a 5/8-inch hole, dropping it at *F*; and Number 6 drills and countersinks the oil hole, finally dropping the piece at *G*. At this point the apprentices get their practice, for they face off the small boss and pile the work up. The drawing, which has proceeded from the lay-out table down to the sixth drill, has been sent on with the first piece passed along. It is finally taken away with the work. Holes that would interrupt the series in this rapid passage are passed through the bank of drills and left for practice by the boys. Where there are two reamed holes in a piece, both of which would be within the range of the first drill, this operator has instructions to do only one, leaving the other hole for the second drill. Sometimes as many as three drills may have to be assigned to reamed holes, a matter which, of course, is determined by the conditions of the work. In the use of this system it will be found advisable to employ apprentices in carrying drills back and forth for the drill press hands, as under this system the drill-men will be busily engaged all the time.

It might at first appear to the uninitiated that this system does not balance properly; that is, that all the drills will not be fully employed; one may be working at its top notch, while another is only working at part of its capacity. This largely depends upon the "layer-out," who should also be the gang foreman. It is his duty to distribute the work when there would not be sufficient work on one series for the whole "bank" to be engaged upon. It may sometimes be necessary to lay out straight drill work, tap holes, etc., for the men on the low-grade machines—a matter that depends entirely upon the judgment of the foreman. CHIPS

PHYSICAL INJURY FROM DRAFTING

After reading the article by B. L. W. in the January, 1911, issue of MACHINERY, engineering edition, we would naturally arrive at the conclusion that drafting work is literally "slow death," that it would work havoc with the most robust of constitutions, and that internal members are sure to show the harmful effect. If the calling is pursued in the manner indicated, these facts cannot be disputed, but the writer is of tne opinion, taken from personal experience and observation,

that conditions normally should not be as deleterious as those cited, in a profession requiring mainly brains, sight and touch.

Undue pressure, or in fact any pressure against the drawing-board, is absolutely unnecessary. The work does not call for such use of this portion of the anatomy, and its application rather denotes laziness on the draftsman's part; for him to inflict self-injury in this manner is an act of indiscretion. The drafting-board should be of sufficient height so that either in standing or sitting the workman has access to it without any effort; it should allow bending at the proper line, the waist, and should offer positive freedom from contact. With large drawings, covering the entire board in width, such as a machine assembly, etc., it is difficult to work on the farther side, and it is far better to kneel on the stool, keeping the body clear of the board, than to create a strain or pressure on the abdomen. The practice, however, of using small drawings in sets, which is rapidly becoming universal, makes such an incident as this rather infrequent. The vertical board, so often recommended, hardly ever finds a place in large drafting-rooms, except for sketch making; it does not seem conducive of accurate work.

The greatest injury due to drafting work is apparently neglected in this article—that to the eyes. This occupation, more than any other form of clerical work, requires excessive application, and the draftsman should use the utmost care; the light should fall on the work properly and with sufficient volume; artificial light should be used as little as possible, and should never be resorted to throughout a bright day—the effect of this practice will soon become noticeable. The stooping tendency, or round shoulders, which easily grows on any one no matter in what walk of life, is easily corrected with proper treatment. Drafting work requires of its followers a steady hand and a clear brain, and he who would be successful must regulate his life accordingly.

The drafting-room is usually the starting place for a successful career in the mechanical and kindred trades, and such a training invariably makes a far more efficient man in line for a position "higher up." To the young draftsman setting out in life, it is not very encouraging to see held up before him as in a mirror the detriments of his profession, especially through misuse of a portion of the body which should be inactive.

L. R. W. ALLISON

Los Angeles, Cal.

WORM VS. CHAIN DRIVE FOR AUTO TRUCKS

The attention of the writer has been directed to the editorial on "Worm vs. Chain Drive for Auto Trucks" which appeared in the March number, engineering edition, and as the statements made are opposed to the experience of the very considerable number of engineers who have now for years been engaged in building automobiles, both pleasure cars and trucks, equipped with worm drive live axles, some remarks in reply seem necessary.

It must be understood, that unless the best workmanship is available, any kind of worm gear is best left alone, and in this matter the writer is entirely in agreement with the editorial. The latter, however, proceeds to state that the efficiency is at best "still relatively low." At this point it becomes evident that modern practice and modern engineering literature have alike been overlooked. The efficiency of worm gears properly designed and correctly mounted is as high as 95 per cent. This statement is made from the writer's own observation and can be calculated from the formula:

$$e = \frac{1 - \mu \frac{P}{\pi D}}{1 + \mu \frac{P}{\pi D}}$$

where μ = coefficient of friction,
P = axial pitch of worm, and
D = pitch diameter of worm.

On page 746 of the "Automobile Trade Directory" published in January, 1911, will be found a table by Worby Beaumont, an engineer of high professional standing in England; as consulting engineer to the Royal Automobile Club, he may be supposed to speak with some authority. This table gives the efficiency of various types of transmission mechanism. Here it will be found that one set of gears will absorb 5 per cent of the efficiency and two chains 6 per cent, or a total of 11 per cent, giving for a bevel and chain transmission of the usual type a total efficiency of 89 per cent against 95 per cent for a worm transmission.

Were it possible to employ for a large truck a single final bevel reduction, the efficiency of the bevel gear would be equal, but not superior to, that of the worm gear; owing to the size of gear which this would involve, such an arrangement is not possible, however, and chains must be employed, making the further reduction in efficiency referred to. Beaumont's figures, however, are for new chains, and it is a fact well known to all engineers that their efficiency falls off rapidly as they become stretched and their sprockets become worn from use, so that the 89 per cent efficiency when new, is probably as low as 75 per cent long before the chains are worn out. It is therefore difficult to see in what way the efficiency of the worm gear is "relatively low" particularly when it is remembered that the wearing of a worm and worm-wheel does not reduce its efficiency at all, owing to the fact that the tooth sides are flat and remain so in spite of wear.

The article next makes mention of the "self-locking feature" of worm gears; it is not a little curious that this point is so frequently brought up; it is so obvious that no automobile could exist with a worm gear were it not possible to "coast" as freely as with a bevel, that it is difficult to conceive any engineer building such a machine unless he had first proved the fallacy of this impression.

Irreversible worm gears are so common in such mechanisms as elevators, and the dividing heads of machine tools, that the uninitiated are apt to overlook the geometrical principles on which the operation of any worm gear depends, and which make it an easy matter for the designer to make the gear reversible or otherwise at his option; it is only a question of varying the gliding angle, which is always a function of the spiral angle, though never equal to, but always greater than this.

As to durability, which is the next point raised, it is probably not generally known that heavy trucks fitted with the worm gear are in general use in England and have been for the last 7 or 8 years. In London omnibus work, where three-ton chassis are employed in what is admitted to be the most severe work to be found, worm gears have given satisfactory results for the last five years.

The writer has before him at present, a letter from the operating engineer of Thos. Tilling, Ltd., the owners and operators of a large number of public service vehicles in London, in which is the statement: "The average life of a worm drive on a ———— omnibus is between 28,000 and 30,000 miles; now that we have re-designed the torque-rod, the life should be 40,000 miles." The writer has yet to find any chain which will in average working approach one-half this distance.

Reliability is much the same as durability, but as the two are mentioned separately in the editorial they will be dealt with in the same manner here. To take only one example, Messrs. Dennis Bros. who were the pioneers of the worm drive for trucks have always given a specific guarantee of two years with every worm-driven rear-axle they have made, and their range of models has for five years included those of five tons capacity. Has any manufacturer of other forms of drive exceeded this?

Lastly the editorial introduces the old argument of complication and unsprung weight and all the disadvantages thereof. This is such an old friend; those of us who have had some experience in the automobile industry have lively recollections of precisely similar objections when the gear drive was first substituted for chains in the lighter vehicle; those familiar with present-day practice know how far they were removed from fact.

The analogy between pleasure cars and trucks is largely in

favor of the latter, inasmuch as their slower speed is in their favor size for size, the destructive effect of shocks, etc., being measured by the energy stored in the vehicle. Since Energy $= \frac{WV^2}{64.4}$ foot-pounds, it follows that destructive action will vary directly as the weight and the square of the velocity. Hence it is simpler to make a live axle for a truck than a pleasure car because of its lower speed.

With regard to repairs, it is obvious that a broken chain can be easily repaired; it is equally obvious that such repairs are unnecessary if no chains exist. If a worm gear will last from 30,000 to 40,000 miles as it does, it may be assumed that roadside repairs are not a frequent occurrence, and as far as the axle itself is concerned it becomes a problem of every-day mechanical engineering to design what will be strong enough for the purpose.

Lastly, the whole question of worm drive for automobiles is regarded as a new and obscure thing—not fit to be understood. That this is the case in this country must be the result of accident or prejudice; it was past the experimental stage ten years ago in England, and such names as Lanchester, Napier and Daimler in pleasure cars and Dennis, Halley and Leyland in trucks, not to mention many others, should be sufficient guarantee that the worm axle is a practical and reliable proposition.

H. KERR THOMAS

Buffalo, N. Y.

AN EXPERT MACHINIST AND ENTERPRISING INVENTOR

I notice the announcement of the recent death of Henry D. Dunbar, inventor of the Dunbar steam-adjusting piston packing. I came in contact with him for a short time about fifty years ago, and have always remembered him as an expert machinist, so it would seem to be eminently proper to say a few words about him, and what he did within my own knowledge.

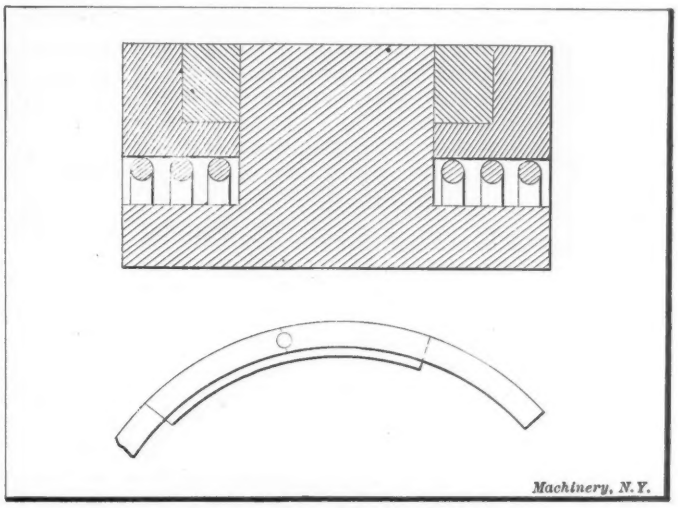
He came to the Starbuck Iron Works, Troy, N. Y., in 1861, and personally introduced and applied his recently patented piston packing, which was at that time a novel departure in that line. The Starbucks were then the builders of tugs for river service, and steam engines, both portable and stationary, so they had considerable use for the packing. Dunbar had been introducing his packing in railroad shops in the South, but when the war began they at once ignored his patent, and made packing *ad libitum*, so he was driven North to see what he could do with it.

When he went to an engine works of any kind he only asked an opportunity to put in a set of the packing, and to show how perfectly it would work; and incidentally he showed how cheaply it could be made. At the time he came to Starbuck's I was running a 20-inch screw-cutting lathe with a swing head, tilting rest, etc., and doing an endless variety of work. In front of me and back to back to my lathe was a 30-inch lathe, strong enough in pull, but rather awkward to handle, none too reliable in any of its movements and with no cross-feed.

One morning when work began there was Dunbar with a "chunky" ring casting near him, and entirely without help he soon had it chucked and started to make a set of packing—bull ring and the small rings, as shown in the accompanying illustration, which were for a 16-inch piston. A little before 6 o'clock (of a ten-hour day), the entire job was completed, the rings sawed, the stop-pins inserted, one in each ring, so as to make them always break joints properly, the plain round wire springs which hold the ring out when the steam was not on were bent and cut to length, and the whole job was laid out in good shape on a board.

It was all done so easily that no one at the time thought it anything remarkable, but when we tried it later no one was able to come up to it. He turned out probably about half a dozen sets while he was working at Starbuck's, and the time made on the first set was about the average for any that he completed. He carried about three special lathe tools in his kit; he also had a circular saw on an arbor with a dog on all ready to stick on the centers, which he used in a small lathe. These were all the special tools that he had.

The Starbucks used this packing on all the engines that they turned out for years, but some changes were later made in it. The two pieces for each section—the rings being sawed in six pieces—were riveted together, and a flat spring was fastened by a screw to each section; but I doubt whether after all, they worked any better than the original Dunbar packing. Dunbar at that time was less than thirty years of age; it is to be hoped that he was fairly paid for his invention and for his pushing of it, but it soon began to be crowded and pushed out by improvements, and so it goes.



Section of Original Dunbar Packing

Mr. Dunbar later and for many years was erecting engineer for the Baldwin Locomotive Works, and it has been stated that it was while holding this position he invented his piston packing; but that cannot be correct. The date of his patent was August 14, 1860, and his residence then was Memphis, Tenn., which corroborates my statement above. Mr. Dunbar died at Evarts, Vt., January 18, 1910, in his 78th year.

FRANK RICHARDS

New York.

AUTOMOBILE MATHEMATICS

Let U = driver of motor,

and V = velocity.

If a sufficiently high value be given to V, it will finally reach *P. C.*

V instantly becomes zero.

For low value of V, *P. C.* may be neglected; but on the contrary, if V be high it is usually best to square *P. C.*, for by Euclid (Book No. ?) $P.C. + £.\ s.\ d. = \overline{P.C.}^2$.

If the value of £. s. d. be sufficiently great *P. C.* will vanish, and V may be extended indefinitely.

Should the difference betwe n U and *P.C.* be great, *J.P.* may be substituted for *P. C.*, in which case the problem is difficult of solution, because no value of £. s. d. has yet been found to effect the elimination of $J.P.$ $\overline{J.P.}^2$ is, in fact, an impossible quantity.

P. H.

[We would suggest that in following out the above reasoning, police constable, the English term for policeman, be substituted for the expression *P. C.* Other substitutions become self-evident.—EDITOR.]

HACKSAW KINKS

The manipulation of a hacksaw is pretty familiar to all mechanics, yet there are some little points that may be unknown to some. For example, when attempting to saw a piece of tubing, if the blade is reversed in the frame, no trouble will be experienced, as the blade will operate smoothly. Also if it is desired to saw a piece of sheet metal, by placing a piece of inch board behind the sheet in the vise, the plate can be sawed through as readily as the board alone.

St. Paul, Minn.

JOEL C. STUART

HOW AND WHY

DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details and name and address. The latter are for our own convenience and will not be published.

GASHING WORM-WHEELS

R. H.—How is the cutter for gashing worm-wheels selected? How should one proceed in gashing worm-wheels? How deep should the gashing cutter be sunk?

A.—The process of gashing worm-wheels was described in detail in the January, 1909, issue of MACHINERY in an article entitled "Machine Shop Practice—Gashing and Hobbing a Worm-wheel," and in the Shop Operation sheets, Nos. 85, 86 and 87, accompanying the same issue.

ELECTRIC WELDING OF SHEET STEEL

J. S.—Can 30 gage, tin-coated, lead-coated, zinc-coated (galvanized), or plain black sheet metal be either lap welded, spot welded or butt welded electrically?

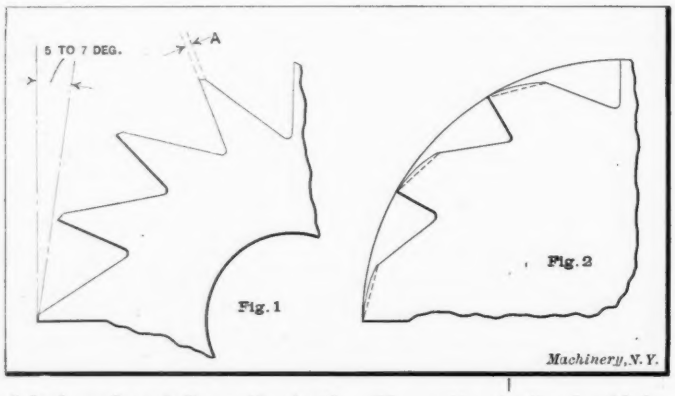
Answered by Toledo Electric Welder Co., Cincinnati, Ohio

A.—It is not a practical proposition to butt weld sheet steel less than 16 or possibly 18 gage. In regard to spot welding sheets which have been tin coated, lead coated or zinc coated, it is more difficult than to weld the plain sheet metal. We have experimented to quite some extent with tin and find that strong welds cannot be made without interposing a thin piece of plain steel. The piece is interposed to increase the resistance at the point of the spot weld. We believe that any of the above metals can be spot welded successfully in this way.

RELIEF OF TEETH OF CUTTERS AND REAMERS

R. H.—In grinding milling machine cutters, should or should not the teeth be backed off up to the cutting edge, or should enough of the cylindrical surface be left back of the cutting edge to support it? Are reamers backed off or relieved on the same principle?

A.—When grinding milling cutters, the teeth are backed off clear to the cutting edge, there being no part of the cylindrical surface left on the teeth. The cutter teeth should be so milled and ground that the width of the land *A*, shown in the accompanying illustration Fig. 1 has the values given below for cutters of different diameters:



Diameter of Cutters	A, inches
2 to 3 inches	1/32
3 to 5 inches	3/64
5 to 7 inches	1/16
7 to 10 inches	5/64

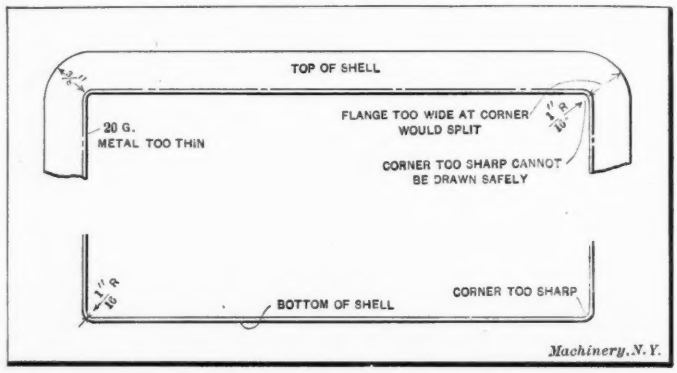
The angle of the clearance or the "backing-off" of the milling cutter tooth should be such that a tangent to the cylindrical surface of the cutter would form an angle of from 5 to 7 degrees with the line of the backed-off surface of the tooth, as shown in Fig. 1. Reamers are frequently relieved in the same manner, although in the case of reamers the width of the land is usually greater. Instead of a flat relief, as shown exaggerated by the dotted lines in the illustration Fig. 2, an eccentric relief, as shown by the full lines, is frequently used. This relief is produced by placing the reamer in a grinding machine as usual, but not on regular centers in line with the spindle, but on auxiliary centers, so that the reamer is held eccentrically. A rocking motion is then imparted to the auxiliary centers, and in this way the grinding wheel, traveling back and forth along the reamer, produces the eccentric or curved relief shown. This relief is particularly suitable for hand reamers which are not intended to remove a great deal of material. When reamers are to remove a considerable amount of metal, the flat relief should be used.

A PROBLEM IN SHEET METAL DRAWING

By A. C. R.

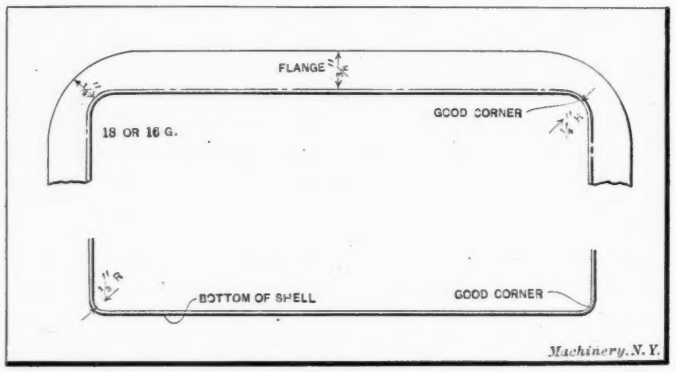
In reply to the query by H. W., with reference to the drawing of a rectangular shell, which appeared in the How and Why columns of the March number of MACHINERY, will say that the shell cannot be safely made as required by his specifications, as will be seen by the accompanying illustrations.

The nature and thickness of the material to be used, which he specifies as steel and No. 20 gage, or about 1/32 inch thick,



makes it absolutely impossible to draw a rectangular shell of the depth he mentions—6 inches—with practically sharp corners at both base and sides, and the leaving of a uniform flange of ⅜ inch all around, the corners included. Fig. 1 represents the shell desired as per specifications, and shows the corners, both base and sides and the flange. In drawing a rectangular shell, the concentration of the metal at the corners in going down is very severe and the radius as given, 1/16 inch, prevents the metal from reducing properly and the result is that the shell is torn at this point in the operations previous to the last, on account of the peculiar shape of these previous successive operations. The corner at the base is entirely too sharp also, as the punch or plunger in drawing will force this bottom through, as the metal is so thin, and it will not stand the strain in reduction.

Fig. 2 shows how this shell can safely be made as to depth and flange. The material is heavier, Nos. 18 or 16 gage being



used, and has a corner substituted, with ¼-inch radius at the sides and ⅛-inch at the base. In bringing this shell down to size there is a peculiar condition at the corners, and as this flange has to be flattened or straightened at this point before being trimmed, a corner such as shown in Fig. 2 is safe and will not split or crack.

Possibly your correspondent can change the specifications to conform to Fig. 2, and if so, the writer will be pleased to furnish particulars to accomplish this. As the matter stands now the shell he specifies is out of the question entirely and practically impossible.

[The query as it appeared in the March number did not give all the data shown in Fig. 1, which was ascertained on further inquiry.—EDITOR.]

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

Comprising the description and illustration of new designs and improvements in American metal-working machinery and tools, published without expense to the manufacturer, and forming the most complete record of new tool developments for the previous month

LARGE TOLEDO SINGLE-CRANK PRESS

The manufacturers of sheet-metal products, as well as the builders of machinery of various types, will undoubtedly be interested in the illustrations and description given herewith of a single-crank belt-driven press of enormous size and weight, recently built by the Toledo Machine & Tool Co., Toledo, Ohio. This press is capable of exerting a pressure of approximately 2000 tons, and it is intended for use in the manufacture of heavy steel products such as embossed plates for burial vaults or caskets, steel doors, parts of Pullman cars and passenger coaches, steel axle housings, large brake drums for automobiles, and other work of a similar nature.

This machine, which is illustrated in Fig. 1, weighs, complete, 275,000 pounds. The slide and connections are provided with the usual threaded pitman screw, fitted with a power elevating attachment. This attachment is controlled by a lever on the left side of the press and it is operated through a pair of friction clutches, (not visible in the illustration) that are attached to the arch in the rear of the press.

Power is transmitted from these clutches by means of miter gears to a shaft connecting, by a second pair of miter gears, with a vertical shaft in front which, in turn, connects with the pitman screw through spiral and worm gears, as shown. Provision is also made for applying a handwheel attachment for obtaining a very close adjustment of the slide when necessary.

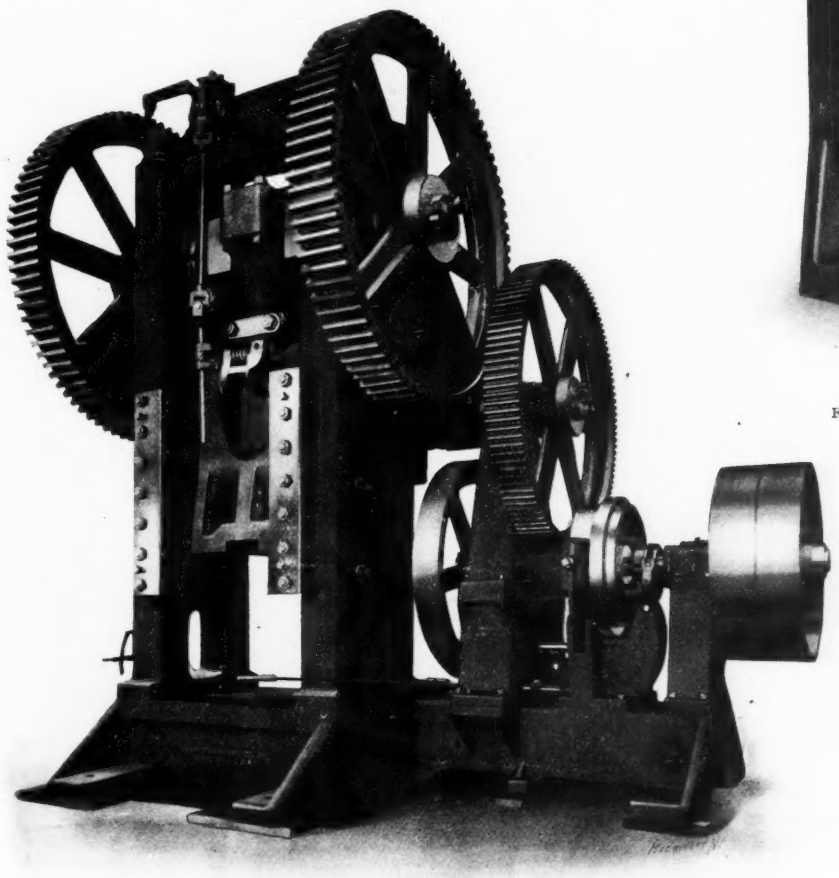


Fig. 1. 275,000-pound Press, built by the Toledo Machine & Tool Co.

The press itself is operated by a very large and powerful friction clutch that is attached to a shaft running in pedestal bearings mounted on an extension that is accurately fitted, doweled and bolted to the main frame of the press. With this construction, a true alignment of the shafts for the pinions and gears is maintained. The press is double back-geared and the gearing is in the ratio of 54 to 1. The back shaft, to which is attached the steel pinions that mesh with the large twin gears on the crankshaft, is large enough to prevent any possibility of torsion between the main gears. This construction equalizes, between the main gears, the great driving power required for obtaining the necessary pressure on the ram or slide.

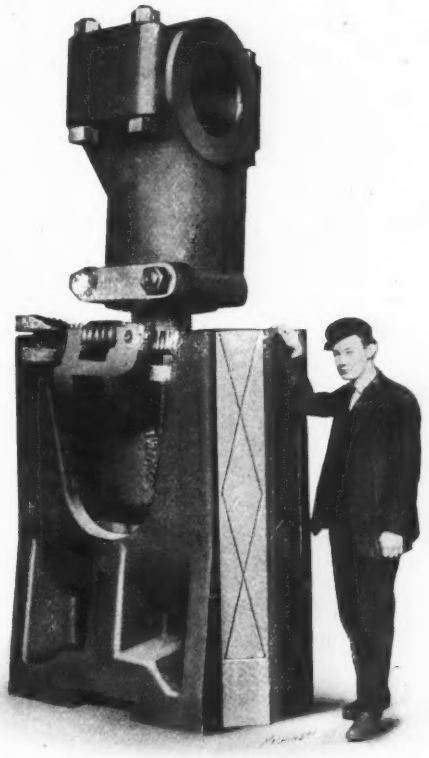


Fig. 2. Assembled Slide and Pitman

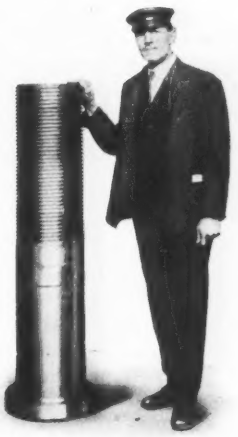


Fig. 3. The Pitman Screw

The main frame of the press is reinforced by four steel rods 8½ inches in diameter, which extend from the bottom of the bed to the top of the arch. The press was completely assembled and tested in the works of the manufacturer before shipment was made, but the tie-rods were not shrunk into position, as the entire press was afterwards dismantled and the frame taken apart for convenience in shipping. The shipment comprised six carloads. After the press was received at the customer's works, the parts of the frame were assembled and the large steel rods previously referred to were then heated, placed in position in the frame

and allowed to cool, thereby shrinking the frame solidly together.

Some idea of the enormous size of this press may be obtained by referring to the accompanying illustrations and comparing the height of the parts illustrated with the men standing by them. Fig. 4 shows the crankshaft with the two main gears attached. The forging for this shaft weighed

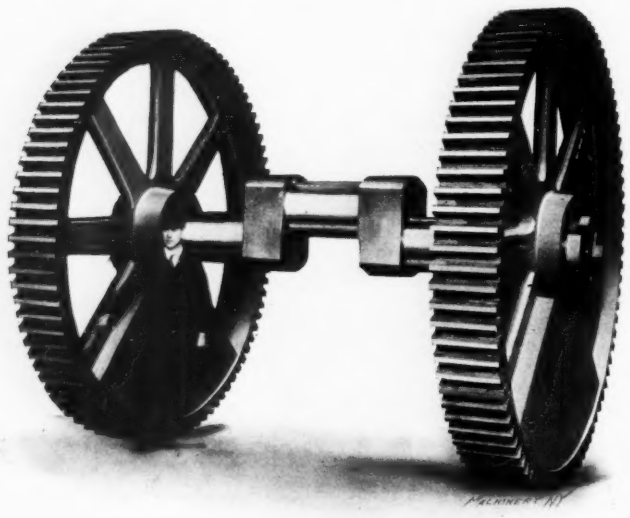


Fig. 4. Crankshaft and Main Gears of Toledo Press

14,000 pounds, and the diameter of its bearings is 16 inches. The two main gears are 123 inches in diameter, and the castings for them weighed 19,000 pounds each. The crankshaft and also the pitman screw are made of high-carbon steel forgings. Fig. 5 shows the friction clutch and shaft for carrying the belt pulleys and balance wheel. This friction clutch is operated by a steel spider which has a double facing of hard wood and is keyed to the shaft. The driving pressure or friction is obtained by means of powerful bell-cranks that are connected to the sliding spider or collar, as shown. Fig.

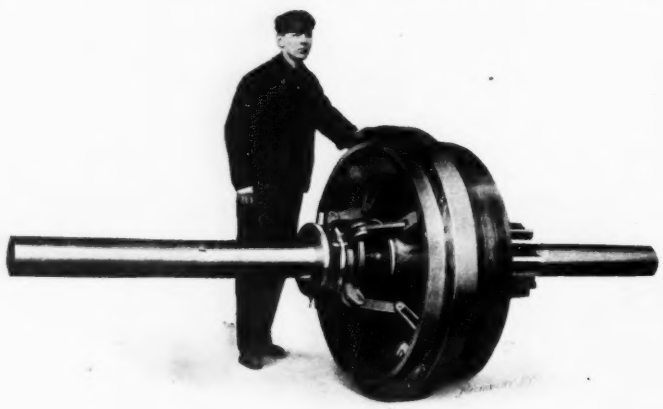


Fig. 5. Press Clutch and Shaft

2 shows the slide and pitman assembled, and Fig. 3 illustrates the size of the pitman screw.

The over-all height of this press is 23 feet. The width between the housings is 60 inches, and the stroke of the ram, 18 inches. The belt pulleys are 60 inches in diameter, 12½ inches wide, and are intended for a 12-inch double belt. This press was designed for the Youngstown Iron & Steel Co., Youngstown, O.

CINCINNATI PORTABLE REAMING AND DRILLING MACHINE

A new design of reaming and drilling machine of the portable electric type, recently brought out by the Cincinnati Electrical Tool Co., Cincinnati, Ohio, is illustrated herewith. The machine is especially intended for drilling and reaming in structural work and bridge building, but can, of course, also be used wherever a portable tool is required. The special feature is that the gearing, which runs in grease, is entirely enclosed, so that there is no chance for the lubricant to work into the armature winding. On the left-hand handle a quick-acting switch is provided, actuated by the corrugated sleeve shown. This sleeve slides back and forth, cutting out the current when in an outward position and closing the connections when moved inward.

The motor is series-wound, and of the air-cooled type. Small holes are provided in the frame for cooling the motor. The latter is geared down to the proper speed for the drill or reamer, the spindle speeds being 200, 350 and 500 revolutions per minute, respectively, for the three sizes manufactured. These sizes have a maximum capacity of ½-, 1-, and 1¼-inch diameter drills or reamers.

The gears are made of high-carbon steel and hardened, and as they constantly run in grease, they will wear indefinitely. The spindle in the largest of the three sizes made, has a hole for a No. 4 Morse taper shank, the medium size for a No. 3, and the smallest size for a No. 2 shank. The two largest sizes have screw-feed for the drill spindle, the spider for the screw-feed being shown beside the tool in the illustration. In-

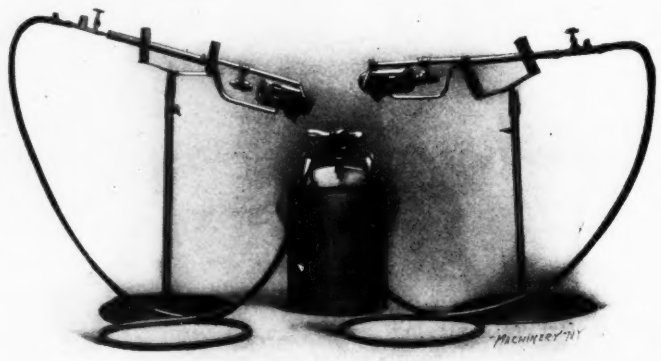
Electrically-driven Reaming and Drilling Machine

stead of the Morse taper, the smallest size may also be provided with a chuck.

The machine is equipped with Hess-Bright ball bearings throughout, no bronze bushings being used for any of the bearings. The weight of the three sizes is about 25, 70, and 85 pounds, respectively.

HAUCK PORTABLE HEATING OUTFIT

In the department of New Machinery and Tools for June, 1910, we illustrated a kerosene blow torch made by the Hauck Mfg. Co., 140 Livingston St., Brooklyn, N. Y., that is adapted to brazing and general shop work. This company has added to its line the portable outfit shown herewith, which



Hauck Portable Kerosene Oil Heater with Two Adjustable Burners

also uses kerosene as fuel. This outfit consists of a seamless tank, equipped with a hand air pump and pressure gage, two sets of burners which are connected with the tank by 12-foot lengths of hose, and two adjustable stands for holding the burners in the proper working position. The particular equipment illustrated is recommended where it is desired to heat both sides of the work simultaneously.

The burners are comparatively simple in construction and so designed that they give a powerful, clean flame which can be easily regulated. This heater is adapted to all kinds of machine shop work, such as melting soft metals, brazing, preheating and general repair work. The torch is so arranged that the tank remains perfectly cool while the burners are being used. It is claimed that these kerosene burners produce a more intense flame than can be secured with gasoline.

In preparing the heater for use, it is simply necessary to operate the hand air pump a few minutes, after having first filled the tank with kerosene oil. As the whole outfit weighs less than 100 pounds, it can easily be carried from one place to another.

NARRAGANSETT DISK GRINDING MACHINE

A disk grinding machine that is designed for grinding both accurately and economically all parts within its range, has been brought out by the Narragansett Machine Co., Providence, R. I. This machine is especially adapted to the grinding of disks, thrust-washers, piston rings, saws, and work of a similar nature. By referring to the accompanying engraving it will be seen that the wheel-head is mounted on a sliding table and is traversed instead of the work-head which is carried on a cross-slide in the rear. This arrangement facilitates

Narragansett 12 by 2-inch Disk Grinding Machine

the operation of the grinder and enables the operator to see the work without difficulty.

The sliding table, which is heavily constructed, has an automatic traverse in either direction that is controlled by adjustable dogs operating against a reversing lever in the usual manner. A spring plunger in this reversing lever can be withdrawn and the table run beyond the reversing point without interfering with the adjustment of the dogs. The table has three feeds for every work speed.

The wheel spindle is hardened ground and lapped and runs in phosphor-bronze bearings. It is provided with means for taking up wear, and it is self-compensating for changes in temperature. The boxes have hinged caps which allow the spindle and wheel to be quickly removed.

The work spindle is threaded on the end to receive a magnetic or other type of work-holding chuck. Its bearings are hardened, ground and lapped and run in phosphor-bronze boxes. Means are provided for taking up wear, both longitudinally and radially. The spindle is driven by a friction-clutch pulley which allows the chuck to be started and stopped independently of the feed or wheel. This clutch is operated by the lever seen to the left of the head, and when used in conjunction with the knob in the center of the traverse handwheel, the work can be placed in position or removed without stopping the countershaft. The spindle has five speed variations ranging from 40 to 263 revolutions per minute. The work head is pivoted so that it can be set at an angle to the ways for grinding conical or concave surfaces. The position of the head is indicated by suitable graduations. This angular adjustment is particularly useful for grinding saws, milling cutters, etc. A taper dowel pin positively locates the head in the zero position. A fine adjustment is obtained by a screw and hand knob. A diamond-tool holder is attached to the side of the work-head allowing the wheel to be trued witnout removing the work. The work is moved laterally by a handwheel at the front of the machine, graduated to read to thousandths of an inch and equipped with a suitable stop for sizing duplicate pieces.

The feed mechanism is mounted on a plate attached to the front of the machine and is self-contained. When the feed is disengaged by a knob in the center of the traverse handwheel, the table can be quickly traversed by hand. The reversing mechanism is of the well-known "load-and-fire" type. It is positive in its action and will reverse with accuracy at the same point for each stroke. The tripping plates are adjustable for wear and adjustment can be easily made without removing the mechanism.

When so ordered, this machine will be equipped with an automatic cross feed. This feed is varied by simply turning a knob, and can be set to indicate one-quarter thousandths on the work. There is also an adjustable stop which disengages the feed when the work is ground to the size for which the stop is set. This automatic feed is recommended where more than one machine is used.

The base of this grinder is of a T-section and supports both the table and work-head from the floor. The interior is fitted with shelves, thus forming a closet for small tools, wrenches, etc. There are three contact points with the floor so that any unevenness will not influence the machine's accuracy. These machines are furnished either with or without a pump and water connections. The pump is of the centrifugal type and revolves in a horizontal plane. It is completely immersed, and is, therefore, always primed and does not require stuffing-boxes or packing. The water is returned to a sediment pan in which the particles of emery and steel settle, instead of being carried into the tank. Traps are also provided for catching any oil before it passes into the tank.

This grinder has a capacity for work up to 12 inches in diameter and 2 inches thick. The bearings and working parts are carefully protected and well lubricated. The ways of the cross-slide and bed are always covered and the top of the bed is enclosed to protect the feed mechanism. Dust caps are provided for the spindle bearings and feed shafts, and all oilers are self-oiling and dust-proof.

"LIBBY" 18-INCH TURRET LATHE

The International Machine Tool Co., Indianapolis, Ind., has brought out an improved design of the "Libby" turret lathe, views of which are shown in Figs. 1 and 2. This machine is driven either by belt or motor and it is equipped with a power rapid traverse for each carriage; automatic trips for each position of the turret; automatic trips laterally for the tool-post; positive geared feeds, and other features to facilitate the rapid and accurate production of work.

The Turret

The turret is of the hollow hexagon type with six holes bushed to 3¼ inches and the faces drilled to receive the various tools. The center of the turret hole is 9 inches above the

ways, and a 10-inch die-head will swing clear. The lock-pin is of hardened tool steel and the lock-pin hole is lined with a hardened steel bushing. Both the lock-pin and clamp are operated by one lever. The turret is operated by hand and as one revolution of the pilot wheel gives a movement of 1 inch, the operator has a good leverage for feeding against heavy cuts. The power rapid traverse for the carriage operates in either direction at the rate of 40 feet per minute, regardless of whether the feeds are on or off. The automatic feed trips are positive and disengage the feed at any predetermined point with accuracy. After these trips have operated, there is an index pointer and graduated scale on the turret which can be used to indicate the depth of the cut being taken; this is a convenient feature when forming work to an accurate depth or thickness. The feeds for the turret carriage are independent of those for the toolpost carriage, both as to amount and direction, and are reversible. The feed variations range from 1/256 inch to 1/4 inch.

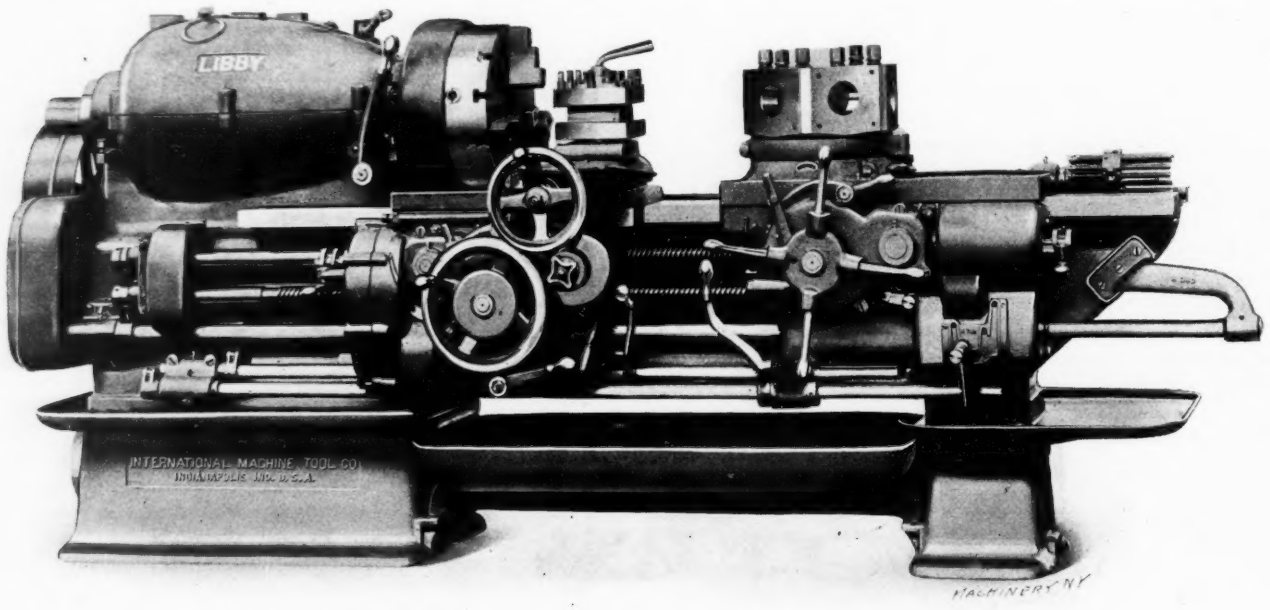


Fig. 1. Eighteen-inch "Libby" Turret Lathe, built by the International Machine Tool Co.

Carriage and Toolpost

The toolpost carriage is of the side type, having a bearing on the front way with a long taper gib on the inside. It is also gibbed to a 60-degree angle on the lower side of the bed to take care of the cross strain. By transferring one bearing to the lower part of the bed instead of having it on the rear way, the full swing capacity of the lathe is obtained. This construction also permits the toolpost to pass the chuck and the turret to come up flush with the chuck, thus doing away with long overhanging tools. The feeds for this carriage range from 1/128 to ¼ inch. The cross feeds for the toolpost are one-half the longitudinal feeds on a standard machine, but they can be made the same as the longitudinal feeds if desired. Hand feeds are possible on both carriages, one revolution of the wheel moving the carriage one inch.

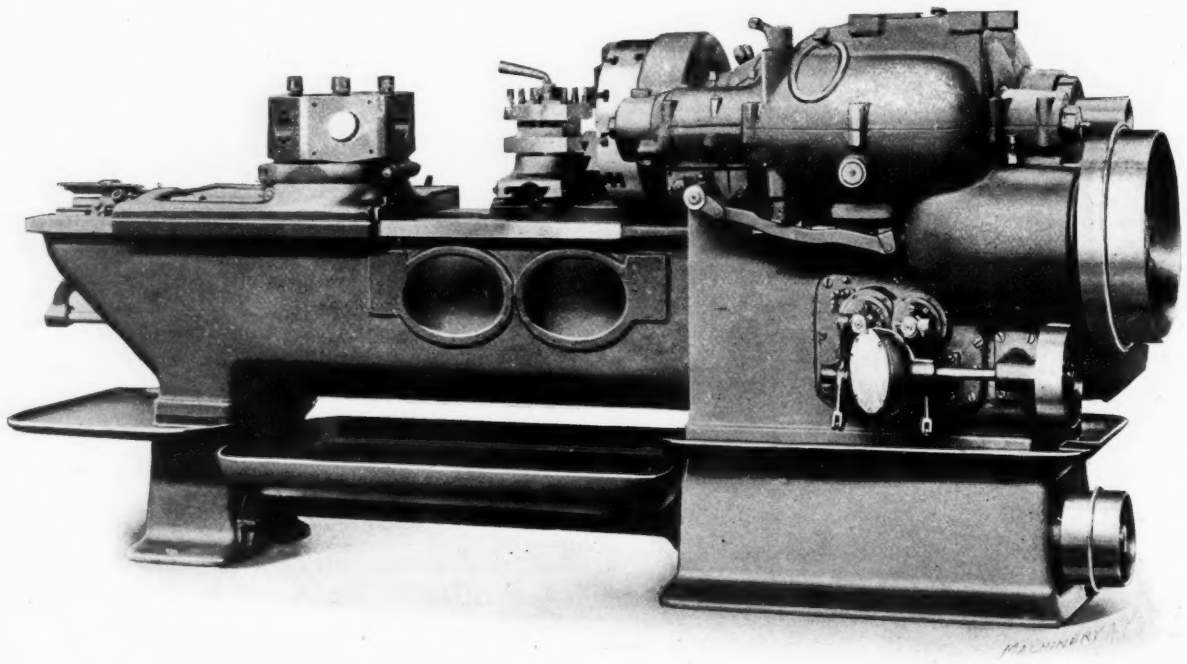


Fig. 2. Rear View of "Libby" Turret Lathe

Rapid Power Traverse

The rapid traverse for the two carriages operates at the rate of 40 feet per minute, and when disengaged, stops instantly. The traverse for the two carriages is also independent, and it can be operated in either direction regardless of what the other carriage is doing, or with the feed on or off. None of the headstock gears or feed gears are used in the operation of this traverse, so that neither the pilot wheel on the turret slide nor the handwheel on the toolpost carriage, turn when the traverse is engaged. The drive is obtained from the main shaft of the machine.

Driving Mechanism

The single belt driving mechanism is separate from the headstock proper, and is fitted into a housing cast integral with the bed and headstock, so that the whole mechanism can be removed in case of repair or adjustment. This mechanism is composed of two friction gears, and drives onto an intermediate shaft giving two forward speeds which, together with the four mechanical changes in the headstock, makes eight forward speeds in all. There are two double frictions in the headstock, one being a band friction in the driving mechanism, and the other a cone friction on the intermediate shaft. In both cases the locking mechanism is such that it gives the effect of a positive clutch, without its disadvantages. All the wearing parts of the friction dogs are of hardened tool steel. These frictions give the operator absolute control of the spindle and chuck.

Bed-lubricating System

The bed and the headstock housing are one casting. The bed has heavy flat ways and, in addition to a rib extending longitudinally through the center, it has cross ribs every 13 inches. The width of the front way is 5⅞ inches, and the back way 3½ inches.

The lubricating system is as complete as possible. The main bearings have ring oilers and reservoirs with sight gages. The oil is carried forward and back on the shafts by means of spiral grooves. All parts in the apron, feed box and rapid traverse requiring lubrication have tubes leading from the outside to the bearings. All oil pans drain into a large pan in the center of the machine containing a strainer. The lubricant flows from this pan into the base beneath the headstock end, which forms a reservoir, and from which the oil is pumped back to the work by a rotary pump. This pump is located in the rear of the machine and is driven from the rapid traverse shaft. A pressure valve causes the oil to be pumped back into the reservoir when the flow is shut off from the work.

Miscellaneous Equipment

The main chuck is 16 inches in diameter and of the three-jawed universal type built especially for heavy service. A two- or four-jawed independent or combination chuck can also be used, and a collet chuck can be furnished for bar work. When a steady-rest is required, it is feathered to a heavy shaft at the back of the machine, in such a way that it rests firmly on and is clamped to the back way when in use, and can be thrown out of the way when not required. This rest is not fastened to and does not interfere with the use of any other part of the machine. This lathe will swing 18 inches over the ways and 16 inches over the carriage. The travel of the turret is 40 inches, and the hole in the spindle is 3⅛ inches in diameter. The shipping weight of the machine is 6000 pounds.

CINCINNATI NO. 5 AUTOMATIC GEAR-CUTTER

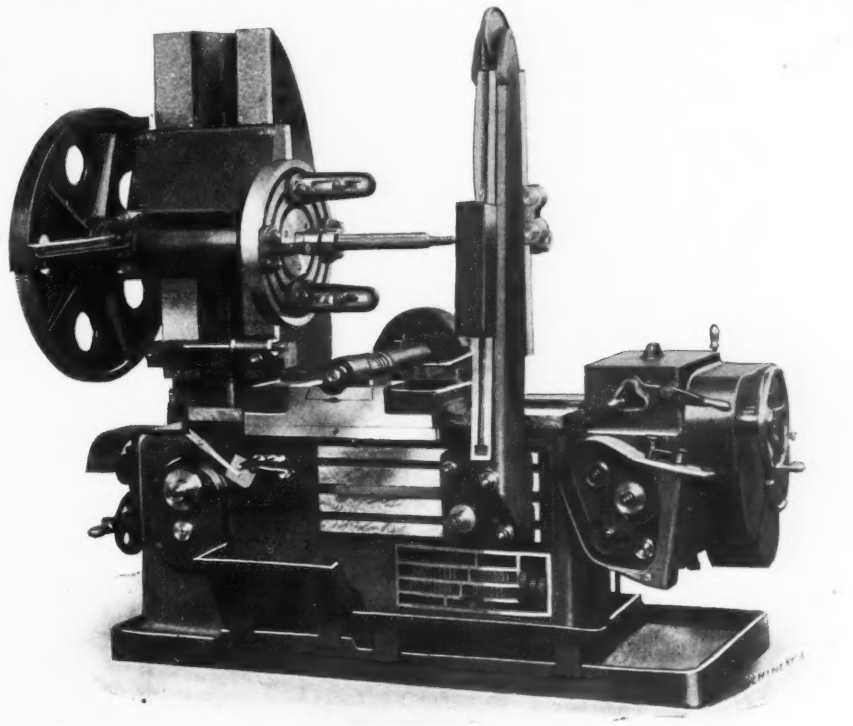
The gear-cutting machine shown in the accompanying engraving is a 48- by 16-inch size, now being built by the Cincinnati Gear Cutting Machine Co., Cincinnati, Ohio. This machine has been designed rigidly, with large wearing surfaces, and with parts of simple construction.

The power is transmitted through a single pulley which runs at a constant speed, and the various speeds and feeds are obtained by transposing conveniently-located gears. All gibs are of the taper type and are adjustable from the ends. The shafts and spindles are all ground and journaled in bronze bushings. The movements are entirely automatic and each movement is dependent on the preceding one so that it cannot take place until the other is completed.

The work saddle is so gibbed to the housing that the work arbor and blank do not drop out of parallelism when the clamps are loosened for adjusting the work to the tooth depth. The power elevating device for the work saddle is operated in either direction by a single lever, and, as the power is taken from the machine pulley, no separate belt is required. There is also a hand adjustment and a micrometer collar reading to thousandths of an inch.

The work arbor is journaled in bronze bushings and it has provision for taking up wear. The arbor is drawn in and forced out by a threaded shaft and handwheel. The faceplate has concentric T-slots, as shown, which are turned from the solid and contain the slotted dogs and jacks. This arrangement enables the dogs and jacks to be clamped in any position. The outer work arbor support is counterbalanced by a weight guided in a dovetail slot.

The cutter slide has rectangular guiding surfaces and long taper gibs for taking up wear. The length of the guiding surface is five times its width thus reducing any binding action. The tappets or dogs for adjusting the length of the



Cincinnati 48- by 16-inch Automatic Gear-cutter

cutter slide feed, are operated by a crank-wrench from the front of the machine. A retractable tappet is provided for the dogs so the slide can be run to the extreme backward position for removing blanks without disturbing their position. A disengaging crank-wheel is provided for moving the slide by hand. The return speed of the cutter slide is constant, regardless of the rate of feed. There are two series of slide feeds, each of which has twelve variations with extremes of ½ inch and 15½ inches per minute. The cutter spindle is large in diameter and has convenient means for taking up wear. The spindle is journaled in a bronze bearing that is adjustable endwise for centering the cutter with reference to a gage furnished with the machine. The drive is through worm gearing and there is means for taking up end thrust wear of the worm. The cutter end of the spindle has a No. 11 B. & S. taper hole for the cutter arbor; this arbor is keyed in the spindle and is drawn in or removed by a threaded bolt. A removable bearing is provided for supporting the outer end of the cutting arbor. One arbor having a diameter of 1½ inch is regularly furnished, but others can, of course, be substituted. The cutter spindle has six changes of speed varying from 24 to 120 revolutions per minute.

It is claimed that the indexing mechanism of this gear-cutter has less gears in the index train than any other machine on the market. The indexing worm can be disengaged from the wheel quickly and be brought back to the exact

meshing depth, or the worm can be disengaged from the index gears and be rotated any desired amount for resetting work and again secured to these gears. This mechanism is so interlocked with the cutter slide feed that it is impossible for the cutter to advance until the work is properly indexed. It is also impossible for the indexing movement to take place while the cutter is feeding, so that work cannot be spoiled. The work spindle can be made to space once, or be revolved continuously by hand movement. Index change gears are furnished for cutting all numbers of teeth from 12 to 100, and, with the exception of prime numbers and their multiples, from 100 to 450. In addition, special gears for cutting other numbers of teeth can be supplied extra.

A countershaft is regularly furnished with the machine, though, if desired, tight-and-loose pulleys will be mounted on the initial shaft. The machine can also be arranged for a motor drive.

STANDARD ELECTRICALLY-DRIVEN ROLLING MILL

The rolling mill illustrated in Figs. 1 and 2 is a recent addition to the extensive line of rolling mills manufactured by the Standard Machinery Co., 7 Beverly St., Providence, R. I.

The mill as illustrated has regular square-section roll housings fitted with rolls 12 inches in diameter and 20 inches wide. The roll journals have heavy phosphor-bronze bearings with crucible steel adjusting screws, but patented roller bearings can also be provided. The upper boxes are supported by side yokes which straddle the adjusting screws that are connected to the boxes by straight rods for lifting purposes. The top of the upper box has a hardened and ground tool-steel washer to take the thrust of the screw. The outer housing for the rolls is attached to the bed with T-bolts so that it can be adjusted in and out, thus permitting the use of rolls having different lengths. The minimum length is 10 inches and diameter 12 inches.

The rolls are driven through cast-steel wabblers and cast-steel wabbler couplings directly connected with herringbone

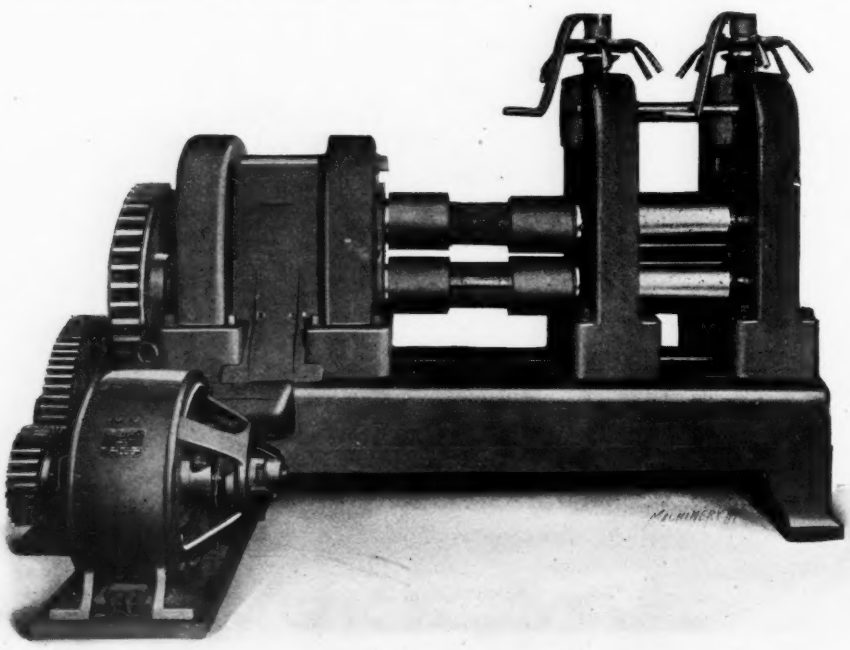


Fig 1. Electrically-driven Rolling Mill built by the Standard Machinery Co.

pinion shafts in the gear housings. These herringbone pinions have a pitch diameter of 13 inches and a face width of 14 inches. They are forced onto crucible steel shafts which have bearings in the housings. These pinions are made of forged steel and the teeth are cut, thus giving a uniform drive to the rolls. This is a very important feature, as it makes possible a uniform rolling of the stock without any wrinkles, waves or other imperfections caused by speed variations or "jumping" of the roll surfaces. If any back-lash in the gearing is transmitted to the herringbone pinions, they act as compensators and do not transfer the movement to the rolls, which would result in unevenness in the stock.

This machine is adapted, when equipped with rolls of special form, to the rolling of copper of large section, moldings, automobile rims, etc., and it is also applicable to the rolling of sheet steel, sheet copper, zinc, German silver, nickel, gold plate, and gold. When used on precious metals, the ingots

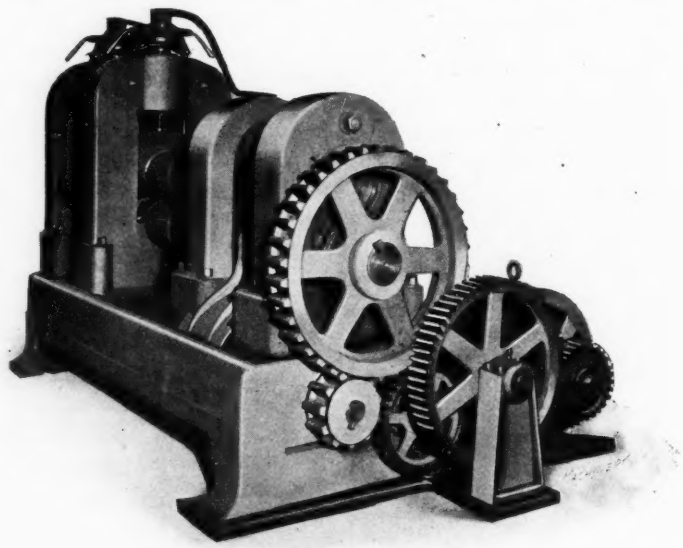


Fig. 2. End View of Rolling Mill, showing Driving Gears

are reduced to a thickness of about ⅛ inch after which they are transferred to finishing or mirror-lapped rolls. It is customary to equip the machine with chilled iron rolls, although when specially ordered, they are furnished with solid hardened and ground steel rolls. Instead of solid steel rolls, those of the shell type are sometimes made by forcing a shell over hardened arbors. The roll ends are threaded to permit the use of cooling water when necessary, the water being forced through special chambers made on the inner sides of the roll. These chambers for chilled iron rolls are cast with two ports on the inner part of the body, and the water is forced in one and out of the other, thus keeping it in continual circulation. When water is to be used with a hardened steel roll, it is necessary to make the roll of the shell type, and the water chambers are cut in the arbor.

The illustrations Figs. 1 and 2 show front and end views, respectively, of an electrically-driven machine, and Fig. 3 shows the same type of mill equipped with a friction clutch. This view also shows the herringbone pinions. The motor-driven mill has a variable speed arrangement consisting of a controller mounted in a panel attached to the side of the mill. This is advantageous for operating the mill quickly, as well as for providing variations in the peripheral speeds of the rolls.

Exclusive of both the motor drive and herringbone pinions, the mill is triple trained, and when the motor gears and herringbone pinions are considered, it is five trained. The total ratio including all the gears is 84 to 1, and the ratio between the driving shaft of the mill and the rolls is 35 to 1. When roller bearings are employed, this ratio is reduced to 24 to 1. The necks of the rolls are chilled, as well as the body, when roller bearings are used, though sometimes they are made of steel and welded into the body of the roll. The roll journals are 9 inches in diameter and 9 inches in length. The main driving gears are made of gun iron and shrouded, and the two trains of gearing contained in the mill proper have cut teeth and are of cast steel.

The adjustment of the rolls is controlled by a spanner arrangement and, for heavy strains, by offset wrenches which are brought down to the height of a man's shoulders. The total weight of this machine including the bed-plate and motor is 27,500 pounds, and it is made in various styles, having both single and double housings. The mill is also fitted either with a friction clutch drive, chain drive or direct gear drive as illustrated.

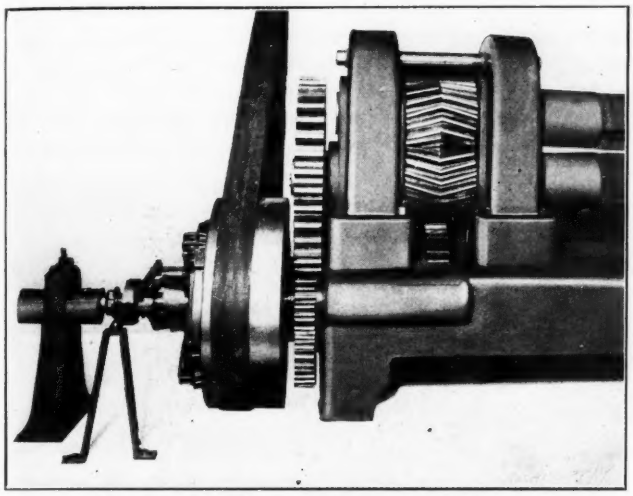
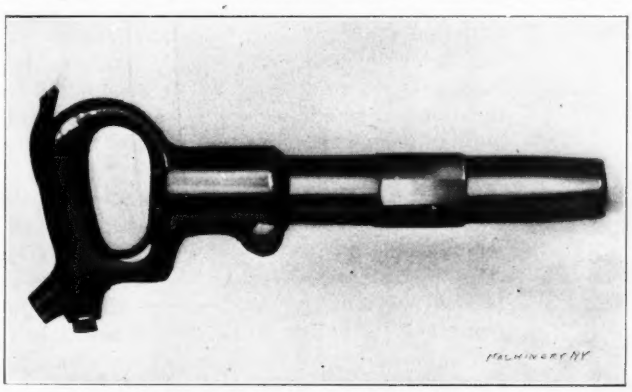


Fig. 3. Rolling Mill equipped with Friction Clutch

DAYTON PNEUMATIC CHIPPING HAMMER

An addition to the line of pneumatic hammers known as the "Dayton" and "Green" types has recently been brought out by the Dayton Pneumatic Tool Co., Dayton, Ohio. This new hammer (see accompanying illustration) is called the "No. 44 Dayton" and differs from the Green type only slightly in design, the main difference being that the Dayton type has an outside trigger, whereas the trigger of the Green type is on the inside. The new hammer is intended especially for use in steel foundries, where the requirements are more severe than in cast iron foundries.



Pneumatic Chipping Hammer manufactured by the Dayton Pneumatic Tool Co.

One of the features which especially adapts this hammer to the work for which it was designed, is the long plunger or piston with which it is provided. The object of this is to obtain more bearing and consequently greater wearing surface, which is desirable and necessary in a hammer for steel foundry use, on account of the fine dust which in these places penetrates into the barrel of even the best protected tool, and which in a short time affects the fit of the cylinder surface and consequently causes leakage. The longer piston makes it possible for the tool to stand up for a much longer time.

Another feature is the poppet style of throttle valve introduced in this hammer, which has been thoroughly tried out for a year past in the company's hammers. This throttle valve is guided by, but not fastened to, its stem, so that in this way the valve has perfect freedom to adjust itself to its seat at all times, and no leakage is possible when the valve is closed. The lower part of the valve body has slots of various depths milled through it, so that a gradual inlet of air is provided for, and thus a perfect regulation is obtained. The main valve is made of alloy steel and hardened by a process which makes it almost impossible to break it, the hardening method providing for the most effective combination of hardness and toughness. In fact, the company guarantees that the main valve will not break during the life of the hammer. The general simplicity of the hammer, and the few parts of which it consists, makes it very easy and cheap to repair, when necessary.

The sizes of this new design are the Nos. 33 and 44 Dayton and Green chipping hammers, having strokes of 3 and 4 inches, respectively.

PATTERSON ADJUSTABLE ELECTRIC LIGHT BRACKET

Proper lighting facilities are, of course, very essential to any shop, as poor light breeds spoiled work and also affects the rate of production. As artificial light is necessary during certain periods even in shops that are well lighted naturally, it is important to have such light as effective as possible. The electric light bracket illustrated in Figs. 1 and 2, which is now being marketed by the Patterson Tool & Supply Co., Dayton, Ohio, is universally adjustable so that the light can be directed anywhere it is needed. This bracket is so arranged that it can be attached to a machine, as illustrated in Fig. 1, or by the addition of a heavy cast-iron base, it is adapted to bench work, as shown in Fig. 2.

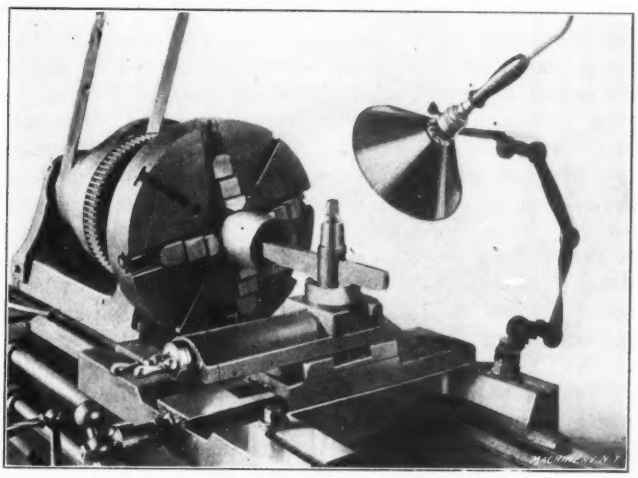


Fig. 1. Adjustable Light Bracket attached to a Lathe

Fig. 2. Adjustable Bracket with Base for Bench Work

The adjustable arms of the bracket are made of sheet steel, and the disk joints connecting them operate on leather frictions and are bound together by strong rivets. The base pieces for machine brackets are made in different forms and have ½ inch holes in which retaining bolts can be placed as

illustrated in Fig. 1. These bases are also provided with four screw holes for locating the brackets permanently. This view also shows how the bracket can be adjusted to throw the light directly in a hole being bored, or at any other point. Fig. 2 shows a bench bracket arranged to direct the light on the face of the work to enable the lines on that side to be seen. If, in this case, it should be preferable to have the light come through the opening from the rear, this adjustment could, of course, easily be made.

The electric lamp is held in the bracket by a screw clamp or with a spring clip. The bench bracket is 23 inches high, and when the first adjustable joint is in a right-angle position, the distance from the center of the stand to the light is 16 inches. The machine bracket has a radius of 21 inches from the center of the base to the light, and it will, therefore, cover a circle of 42 inches in diameter.

CINCINNATI 20-INCH HEAVY-DUTY PULLEY LATHE

The Cincinnati Pulley Machinery Co., Cincinnati, O., has recently placed on the market a 20-inch heavy-duty pulley lathe, embodying features not found in previous designs. A general view of the machine is shown in Fig. 1. The particular feature in which this design differs from the company's previous machines is the feed arrangement which is entirely new; in addition, a power cross-feed has been provided.

In Fig. 2 is shown a view of the feed gearing and transmitting mechanism, the headstock of the machine having been removed to show these features clearly. The feed mechanism is driven from a gear on an intermediate shaft, located just above the pulley shaft, as shown in Fig. 1. This intermediate shaft has its bearing in the headstock and is, therefore, removed in Fig. 2. The gear on the intermediate shaft meshes with the intermediate gear *A*, which, in turn, meshes with gear *B*, and the latter is fastened onto the projecting hub of the clutch gear in the feed box at the end of the machine.

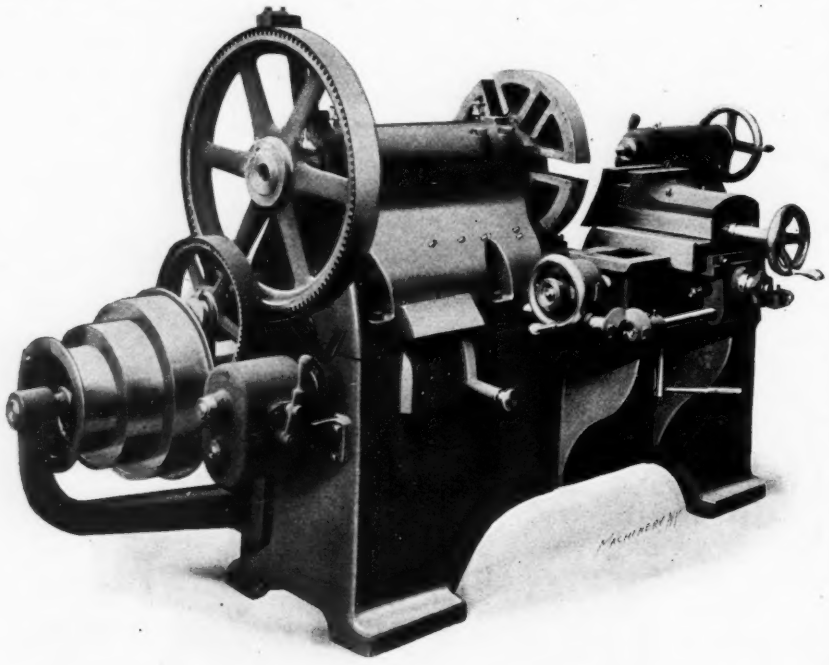


Fig. 1. Pulley Lathe, built by the Cincinnati Pulley Machinery Co

One set of feeds is obtained by direct drive through this gear, and one set of feeds through the feed box gearing by changing the position of a lever on the feed box at the end of the machine. The change gearing underneath the headstock, which is of the well-known tumbler gear design (as shown in the dismantled view), provides for six changes, so that, in all, twelve feed changes are available. The ratio of the smallest to the greatest feed is as 1 to 16, so that ordinarily a feed range of from 1/64 to 1/4 inch is obtainable. The driving feed gearing can, however, be so modified, if desired, that a feed range of from 1/32 to 1/2 inch may be obtained.

From the cone-gear shaft, the feed motion is transmitted to the carriage of the lathe by means of a pair of bevel gears, universal-joint shafts and a worm and worm-wheel, as indicated. The universal joints between the bevel gear shaft and the worms, permit swinging the table for turning the crowned faces of pulleys. This feature of the design constitutes a considerable improvement over previous methods used for transmitting the feed, and provides for a positive feed motion at all times.

The power cross-feed is obtained directly from the feed gearing. The shaft of the worm for the longitudinal feed motion projects beyond the worm-gear, and on its end is placed a bevel gear meshing with another gear on the feed rod. The feed rod has a worm mounted on it inside of the apron, and this worm meshes with a worm-wheel on the friction shaft, on the end of which is the friction knob shown on the apron in Fig. 1. The friction shaft also carries a cone friction, engaging with the worm-wheel, the friction having keyed to it a spur gear meshing with the tumbler gears used for reversing the feed motion and which, in turn, mesh with the gear on the cross-feed screw.

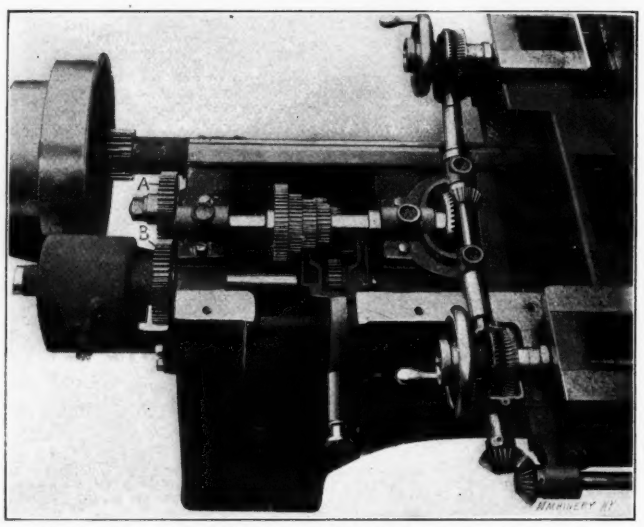


Fig. 2. View of Pulley Lathe with Headstock removed to expose Feed Mechanism

As in previous designs, the spindle has six speeds, obtained by means of a two-speed countershaft and the three-step cone pulley. The range of spindle speeds is from 7 to 30 revolutions per minute. The ratio of the gearing from the cone pulley to the spindle is 18.1 to 1.

The table of the machine swivels about its center, and a series of holes is drilled on one side so that a different pre-determined taper will be obtained from each hole. Thus, when the table is adjusted, both rails are set simultaneously.

As will be noted, all gearing is provided with suitable guards, and the worm and worm-wheel operating the feeding mechanism, and all other feed gears, are entirely enclosed. The machine is especially intended for turning and facing pulleys, gears, flywheels, couplings, and work of similar character. This machine is provided with an ordinary engine lathe tailstock, which was not regularly furnished with previous designs. The capacity of the machine adapts it to the turning of pulleys from 4 to 20 inches diameter, and up to 18 inches face. The floor space occupied is 8 by 5 feet, and the weight of the machine is 4500 pounds.

DRESES DRILLING, BORING, FACING AND TAPPING MACHINE

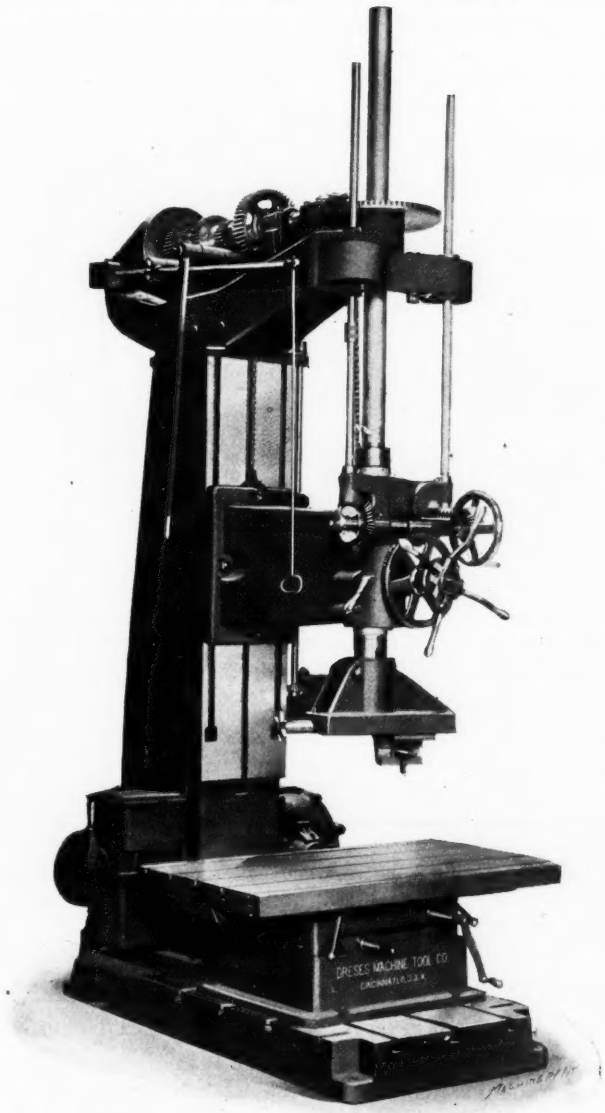
The Dreses Machine Tool Co., Cincinnati, Ohio, is now building the 60-inch drilling, boring, facing and tapping machine, illustrated herewith. This machine is intended for heavy drilling or tapping operations, for machining holes in

steel plates, bars, or connecting-rods, and for boring and facing parts that cannot conveniently be machined in a lathe or boring mill.

The driving mechanism of this machine is similar to that of an upright drill, but it is provided with a frictional starting, stopping and reversing device that is operated by the handle located at the side of the head. This handle is adjustable so as to be always within easy reach of the operator. The horizontal bar to which the fork and friction clutch arrangement is attached, is balanced with a weight as shown, and there are also spring dowel pins so that the clutch cannot engage itself. The back-gears are operated by steel clutches, and engagement or disengagement is effected by the vertical lever seen to the left of the column.

As the illustration shows, the feeding mechanism of the head is connected with the spindle by two vertical shafts, arranged on each side, which connect through bevel gearing with the worm-shaft for the feed. This arrangement gives two different kinds of feeds. The rod to the left operates four fine feeds that are used for ordinary drilling and boring, whereas, the right-hand rod gives a feeding movement equivalent to the leads of standard pipe threads.

A facing head that is used on this machine is shown attached to the nose of the spindle in the illustration. This



Heavy Drilling, Tapping, Boring and Facing Machine, built by the Dreses Machine Tool Co.

head is operated by a star feed and its construction is obvious. Both the spindle and its head are balanced by a weight located inside the column. The table is of the compound type and has a longitudinal movement of 40 inches and transverse movement of 8 inches. The machine illustrated is driven by a multi-phase, constant-speed, twelve-horsepower motor, and the speed changes are obtained by a five-step cone and the back-gears.

HENRY & WRIGHT HIGH-SPEED RADIAL DRILLING MACHINE

The Henry & Wright Mfg. Co., Hartford, Conn., has designed a high-speed radial drilling machine especially for driving small drills that depend more on speed than feed for efficient operation. Experiments made by this company show that when drilling holes ½ inch or less in diameter, power can be more economically and efficiently used by dividing it so that the greater part is expended in the form of speed, and

Henry & Wright Radial Drilling Machine, designed especially for Drilling Small Holes

the least in the form of feed. In other words, the power for speed should be greatest for driving small drills and gradually decrease as ½ inch is approached; a point is then reached where to obtain the highest efficiency, the power should be divided equally in the form of speed and feed. From this turning point, power should be used in an increasingly greater proportion in the form of feed with a corresponding decrease in the form of speed. These results indicate that machines for driving drills larger than ½ inch, should be built much stiffer and heavier than for driving smaller drills, whereas a machine used for holes averaging less than ½ inch, should be constructed for fast operation and without those features which make the heavier design cumbersome and inefficient for small work.

The light high-speed radial machine shown herewith is designed especially for drilling small holes, and it is not intended for the field covered by heavier machines. This machine can be driven much faster than the more powerful designs, and it uses only a fraction of the power which the heavier types require. It is equipped with ball bearings throughout, including the swinging column, thus reducing friction and wear to a minimum. The column and table are equipped with locking screws so that they can be rigidly held in the desired position. The overhang of the arm is 30 inches, but as the table revolves on ball bearings, the operator can frequently reach a point 60 inches away from the column by simply revolving the table with the foot. The machine is driven by a 2-inch belt which connects with the spindle, as shown, and there are eight speed changes.

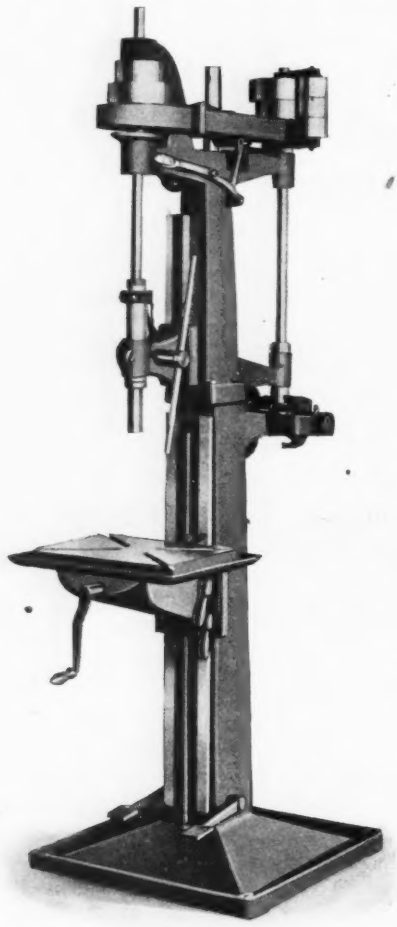
A new feature of the spindle drive is the method of transmitting power to the spindle below instead of above the

pulley, which allows the use of a shorter and stiffer spindle. The spindle pulley is enclosed in a bracket so as to eliminate as far as possible all belt strains. This machine has sufficient power to drive drills up to 1⅛ inch in diameter, and it can be used for tapping holes up to ½ inch in diameter.

The equipment includes a countershaft with a clutch, and a sub-table for handling small parts. This machine is especially efficient for drilling small holes in bulky parts, and the swinging spindle in conjunction with the rotating work table, enables the drill to be quickly located.

REED HIGH-SPEED DRILLING MACHINE

A high-speed sensitive drilling machine of the straight-line box type has been designed by Francis Reed Co., 43 Hammond St., Worcester, Mass., to meet the demand for a machine that is both sensitive and capable of driving comparatively large drills. During the test to determine the machine's capacity, a 1-inch hole was drilled through an inch of cast iron in eight seconds, and a ½-inch hole was drilled through an inch of cast-iron in three seconds, high-speed drills being used in both cases.



16-inch High-speed Drilling Machine, built by Francis Reed Co.

This machine has a cone belt shifter, a belt tightener and a line belt shifter. The cone belts are shifted mechanically by a lever located on the right side of the column. This lever is moved vertically to shift the belt, which passes through eyes in the ends of the shifting levers. These eyes or guides are located near the cones and the belt is easily changed from one step to another.

The belt tightener swivels about the vertical driving shaft in the rear, and, in addition to increasing the belt tension, it also increases the arc of contact, thus giving greater pulling power. This tightener is operated by a handwheel on the left side of the machine, through a rack-and-pinion movement, and it is interlocked with the belt shifting device so that the initial movement of the shifter releases the belt tightener, thus making it unnecessary to shift a tight belt. The belt itself is of special heavy leather, and endless. The line belt is shifted by two pedals located on each side of the base as shown; a slight pressure on either one starts the machine, and a repeated pressure on either stops it.

This machine has been designed with a view to accessibility and convenience, and it is easily controlled by the operator from the working position. The table tightening handles, the elevating crank, the cone belt shifter, and the line belt shifters are all operated from the front. The spindle is bored to receive a No. 3 Morse taper to accommodate all drills up to the full capacity of the machine. The spindle cone has a heavy top support to relieve the spindle of strain. All shafts are ground, and fast-moving shafts run in bronze boxes of large area and are interchangeable. The bevel gear on the vertical driving shaft at the rear is made of composition fiber to insure a noiseless transmission. These machines will be built with from one to four spindles. The weight of the single-spindle type illustrated is 480 pounds.

Some of the principal dimensions are as follows: Vertical feeding movement for the spindle, 6¼ inches; vertical adjustment of the head, 9½ inches; vertical adjustment of the table, 30 inches; size of table, 12 by 16 inches; maximum distance from spindle to table, 36 inches; diameter of spindle in the quill and cone, respectively, 1 inch and 15/16 inch. The machine will drill to the center a 16-inch circle.

CENTERING TOOL FOR THE LATHE

The illustration Fig. 1 shows a tool for centering work in the lathe known as the "Sure" center finder. The body of this centering tool contains a combination drill and countersink at one end and it has an enlarged 60-degree center at the other which fits on the regular tailstock center of the lathe. When it is held against the tailstock center as illustrated in Fig. 2, it aligns itself, and the combination drill can be used for centering by feeding it against the work with the tailstock in the usual manner. The friction between the body of the tool and the lathe center is sufficient to hold it for drilling and countersinking, so that it is simply necessary to steady the tool with the hand. Each center finder is provided with a combination drill and countersink which are stock sizes with many manufacturers.

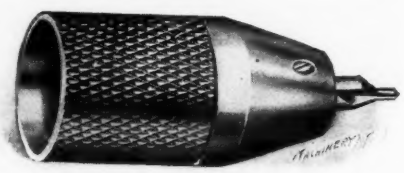


Fig. 1. Lathe Centering Tool

These tools are made in four sizes having drill diameters ranging from 3/64 inch to 1/8 inch. The first two sizes have a single-end drill and countersink to make them more compact, though the double-ended type may be used if desired.

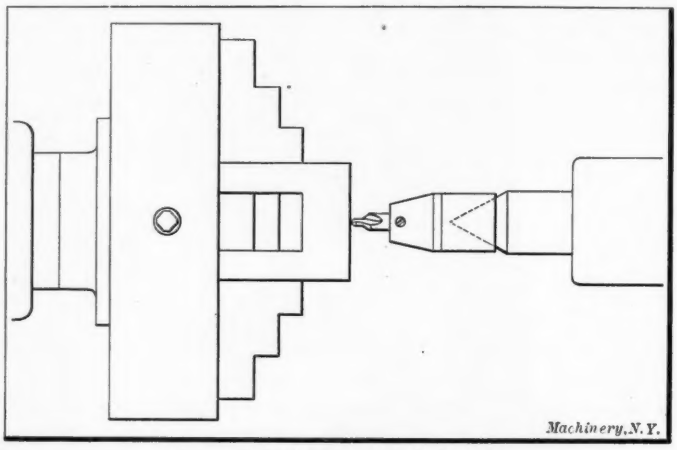


Fig. 2. Method of using Centering Tool

The two larger sizes are regularly supplied with the double-ended drill and countersink. This tool is manufactured by W. A. Peck, 141 Brewery St., New Haven, Conn.

LE BLOND HEAVY-DUTY CRANKSHAFT LATHE AND EQUIPMENT

An improved form of lathe with special equipment for rough turning gas engine crankshaft pins, is shown in Fig. 1. This lathe is a heavy-duty type built by the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio. It is equipped with special adjustable headstock and tailstock fixtures designed to take crankshafts having strokes up to about 6 inches. There is also a heavy carriage carrying a three-tool turret toolpost with individual cross-stops for each tool; a roller steadyrest; automatic stops for longitudinal feed; and a pan bed with pump for supplying cutting lubricant.

The headstock fixture is carried on a faceplate mounted on the spindle and so arranged as to be adjustable for different

throws. When the proper adjustment for a given throw has been made, the slide is secured by four T-bolts. A graduated scale and adjusting screw permit of accurate adjustments. The revolving fixture is accurately indexed by a hardened steel plunger in the slide which has hardened bushings in the fixture. The index is so divided that the fixture may be rotated 120 or 180 degrees, making it adjustable for 2-, 4-, and 6-throw cranks. After indexing, the fixture is clamped by two T-bolts which engage a circular T-slot. The revolving fixture is equipped with removable split bushings which can be replaced to fit the line bearings of different sized crankshafts. The work is driven by a V-shaped dovetail piece, having a hand-nut adjustment, which also centers the pin by the cheek or web. The crank is held in position by a hinged clamp on the fixture.

The tailstock fixture is also adjustable and it is mounted on a spindle which revolves in a bushing in the tailstock barrel. The adjustment is obtained in the same manner as on the headstock fixture, and removable split bushings as well as a hinged clamp are also employed.

The method of chucking a crank is as follows: The two fixtures are brought into alignment by two locking pins. One of these is located in the head and enters a bushing in the large faceplate, and the other is in the tailstock and engages the tailstock fixture. The crankshaft is delivered to the machine with the line bearings rough turned, and it is clamped

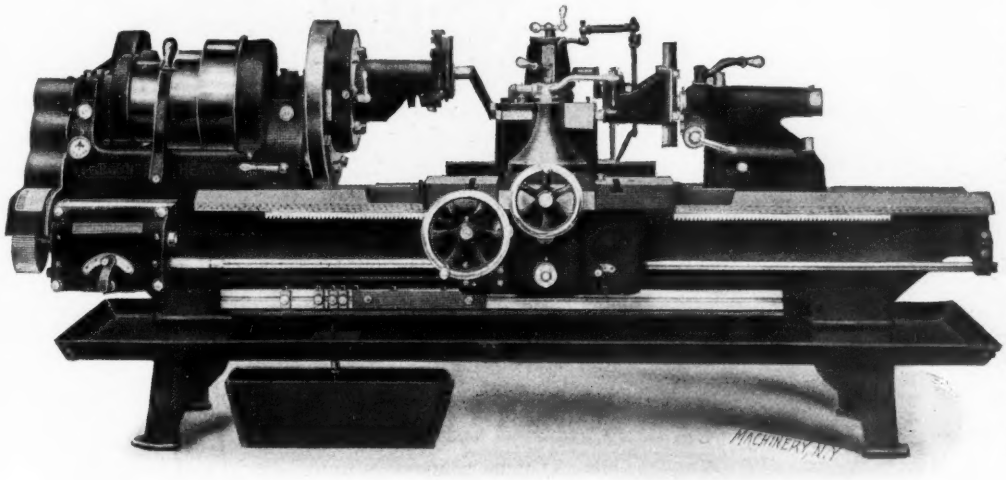


Fig. 1. Le Blond Heavy-duty Crankshaft Lathe

by the hinged clamp previously referred to and centered by the V-shaped driver. The locking pins for both fixtures are then withdrawn and the machine is ready to turn two of the pins. After these have been machined, the fixtures are again aligned by the locking pins, the two T-bolts of the headstock fixture and the hinged clamp at the tailstock are released, the indexing plunger is withdrawn and the headstock fixture and crank are turned 180 degrees or until the index plunger drops into place. The crank is then clamped at the tailstock end and the revolving fixture is secured by the two T-bolts

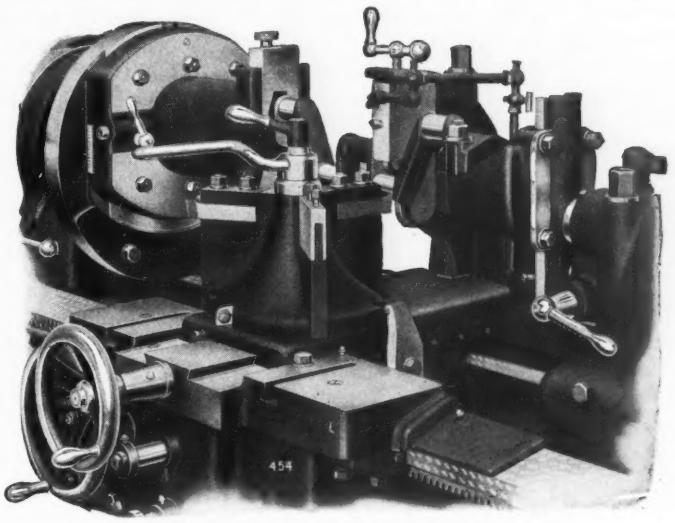
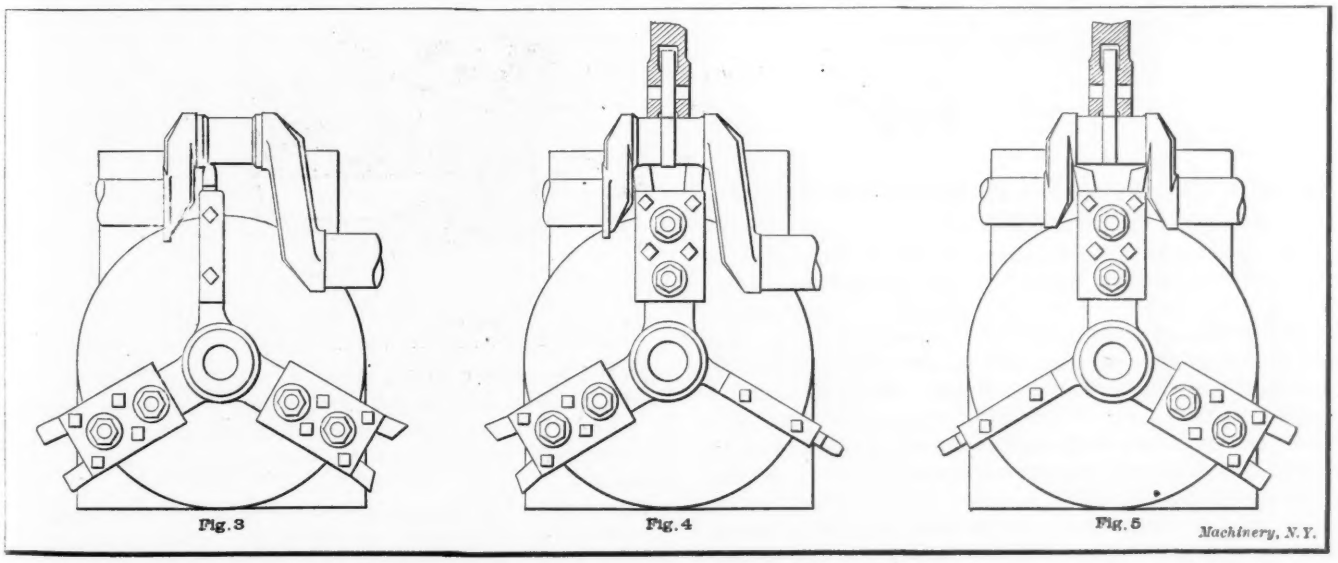


Fig. 2. Tool Equipment for Crankshaft Turning

previously referred to. After the locking pins are withdrawn, the lathe is ready to turn the two opposite pins.

The tool equipment on this machine, which is illustrated in Fig. 2, is something new in crankshaft lathe construction. Instead of using front and rear tool-blocks as with the old equipment (illustrated in the department of New Machinery and Tools, October, 1909), all the tools on this machine are carried in a three-tool turret tool-block. This gives a more substantial tool support, as all the stress is downward on the shears during the heavy filleting operation, thus eliminating the tendency to lift the carriage, as was the case when the filleting tools were mounted in the rear.

The method of turning a crankshaft is as follows: A round-nosed turning tool is first fed into a cross stop as illustrated in the plan view, Fig. 3, which gives the proper diameter. The feed is then engaged and the tool feeds across the pin until the automatic stop lever engages the first stop, which throws out the feed automatically. The carriage is then moved against a positive stop by means of the handwheel. The roller back-rest is next adjusted against the work by the cross-



Figs. 3, 4 and 5. Plan Views showing Arrangement of Tools in Turret Tool-block of Crankshaft Lathe, and Successive Steps in finishing Pin

feed handwheel operating through a telescopic screw, and the filleting tools are brought into position as in Fig. 4. These are run in against a stop, removing the part left by the turning tool and giving the pin the proper width and fillets of the correct radius. If the crankshaft has straight webs which must be finished, two tools are used as in Fig. 5, which face the webs to the correct width. During these last two operations, the crank is supported by the roller backrest, thus eliminating any tendency of the work to spring.

After one pin is finished in the manner described, the backrest is moved out of the way, the automatic stop lever raised and the carriage shifted to the next pin, and the operation repeated.

The tools are held in position on the turret by studs, and they can be moved and other tools quickly substituted, for pins of different widths. In fact, the equipment is designed so that the adjustment and changes for crankshafts of different sizes and styles can be easily and quickly made. The turret and principal parts of the fixtures are made of steel castings, and the index plugs and bushings are hardened. The lathe itself has a new form of compensating V and a single casting box-type of apron. The feed box has sliding gears and gives eight feed variations. All the gears in the apron

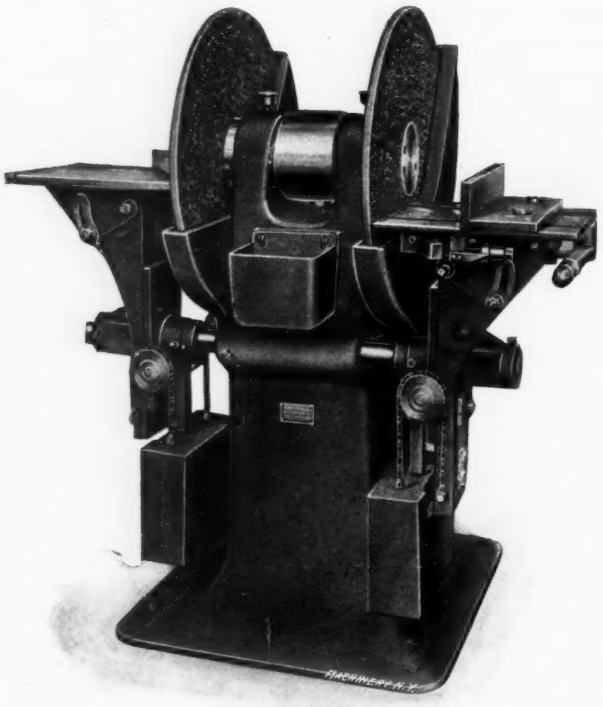


Fig. 1. Rowbottom 26-inch Disk Grinder

and feed box are of steel. This machine is furnished either with a three-step cone and double friction back-gears, or with a single-pulley drive.

ROWBOTTOM 26-INCH BALL-BEARING DISK GRINDER

The Rowbottom Machine Co., Waterville, Conn., is now manufacturing an interesting design of disk grinder which embodies in its construction a self-contained dust exhauster, counterbalanced work tables, and ball bearings for the spindle. Fig. 1 of the accompanying engravings is a front view of this grinder, and Fig. 2 is a view of the rear which shows the exhauster.

Each table is counterbalanced, for convenience in making vertical adjustments, by a weight suspended on two chains that pass over sprocket wheels and connect with the table on each side, as shown. These tables can be given a rocking motion across the face of the disks or can be fastened in a stationary position. They also have an angular adjustment with relation to the faces of the disks. The weights are kept in alignment with the tables by guides which prevent any swinging movement. The right-hand table has a sliding motion to and from the disk, operated by the hand-lever shown and controlled by an adjustable stop-screw graduated in thousandths of an inch. This table also has two T-slots for attaching angle-plates or fixtures. The left-hand table is equipped with an adjustable gage for locating work in an angular position horizontally.

The dust exhauster, which is bolted to the pedestal, is driven from the same countershaft as used for the grinder. All sparks and dust are drawn by the exhauster fan down through

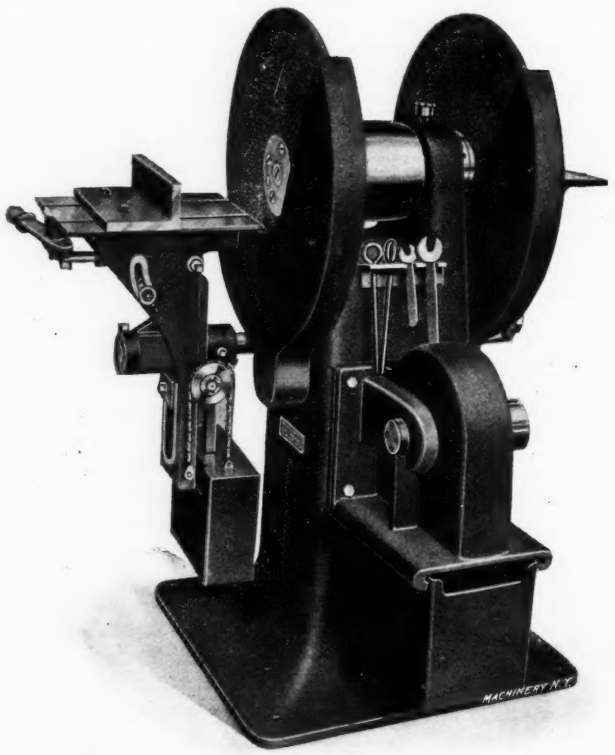


Fig. 2. Rear View of Disk Grinder, showing Self-contained Dust Exhauster

the disk guards and the machine pedestal, into a removable water box. This box is located just beneath the fan, as shown, and it can easily be withdrawn for cleaning, when necessary The exhauster enables the grinder to be placed adjacent to other machinery without danger of injury to the bearings because of dust. As the exhauster is self-contained, piping to independent exhaust systems is unnecessary, and it also meets the approval of the fire insurance inspectors.

The ball bearings for the spindle are of the Hess-Bright

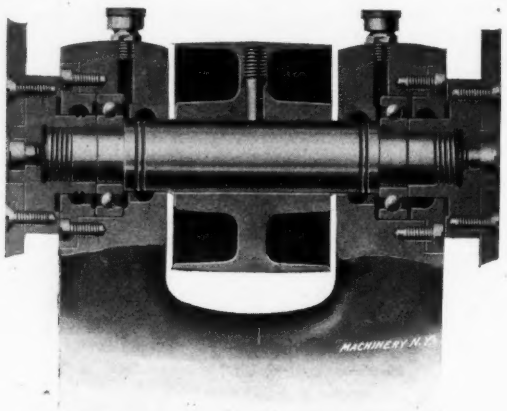


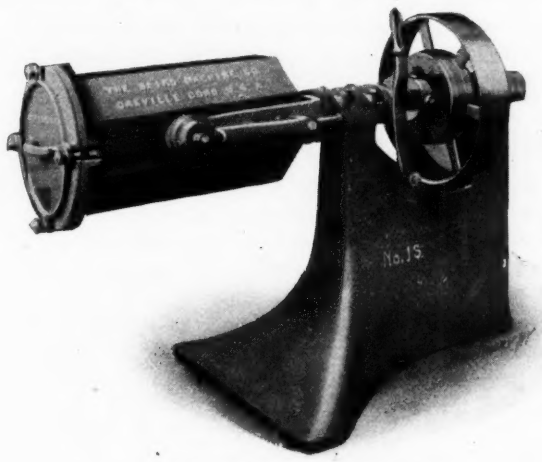
Fig. 3. Sectional View of Spindle and Bearings

type and are shown in the sectional view, Fig. 3. This construction gives durability and effects a considerable saving in power. The bearings also require little attention, as they are constantly supplied with lubricating grease from the cups shown.

The disks of this grinder are 26 inches in diameter, and the spindle pulley measures 8 by 5½ inches. The speed of the disks is 1200 revolutions per minute. The work tables have a width of 13 inches and a length of 17½ inches, and a vertical adjustment of 7½ inches. The equipment regularly furnished with each grinder includes all necessary wrenches, four steel disks, countershaft, cementing press, one dozen emery cloth disks, and one gallon of cement.

BAIRD SINGLE BALL-BURNISHING BARREL

The latest addition to the line of tumbling barrels manufactured by the Baird Machine Co., Oakville, Conn., is shown in the accompanying halftone. This is a single-barrel machine designed particularly for small concerns, and also for handling special or experimental work. It is equipped with a friction clutch drive, "tiltable" barrel, a brass cover, a wood-lined barrel, and other features common to the duplex

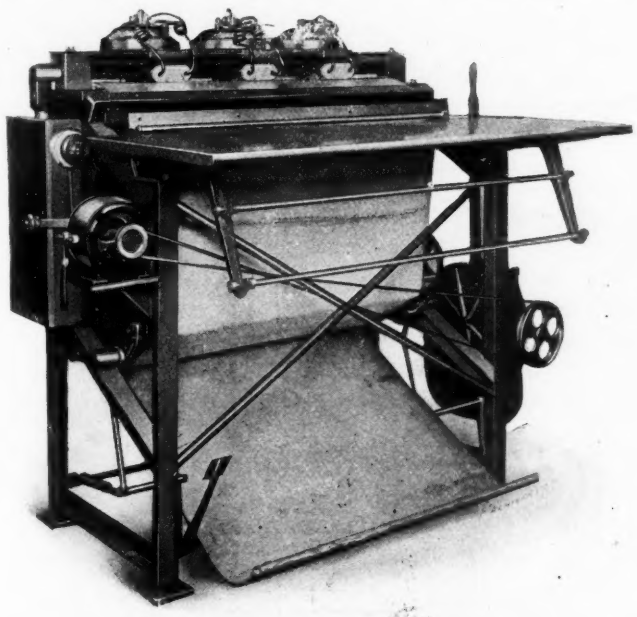


Baird Ball-burnishing Barrel

machine built by this company. The friction clutch pulley allows the machine to be belted direct to the main shaft, and either parallel or at right angles to it. This single-barrel type is built in two sizes, designated as Nos. 1 and 2. The barrel of the No. 1 size is 10½ inches in diameter and 24 inches long on the inside, and the No. 2 size is 16 inches in diameter and 30 inches long.

PEASE CONTINUOUS BLUEPRINT MACHINE

As the tendency of manufacturers is toward the use of small blueprints for shop use, the C. F. Pease Co., 166 W. Adams St., Chicago, Ill., has brought out the improved design of continuous blueprint machine illustrated herewith, which is made in 24- and 30-inch sizes, to meet the demand for a small machine. The illustration shows a 30-inch size or one



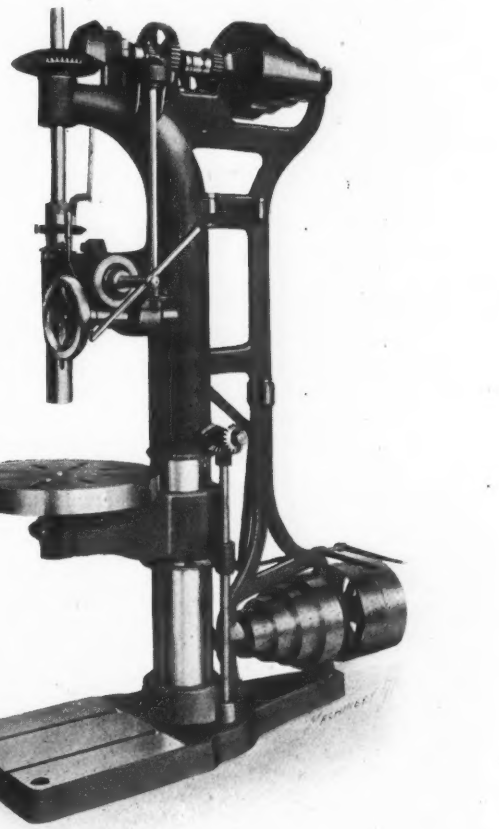
Blueprint Machine built by C. F. Pease Co.

for tracings up to 30 inches in width. This machine has three arc lamps of low amperage, and the 24-inch size, two lamps. The smaller size has a capacity for printing from fifty to seventy-five 24- by 36-inch prints per hour, or double that quantity of 18- by 24-inch prints. It occupies no more space than an ordinary desk or small drafting table, and can be placed in a corner of the drafting-room without annoyance, as it is practically noiseless.

All tracings are fed over the feeding table on top of the sensitized paper and right side up. There is no slipping of the tracings, and a good contact is obtained. The paper and tracings are carried down past the bent glass, by means of an endless canvas belt, into a tray below, from which they are removed by the operator at the front of the machine. This form of printer can be used for printing either from sheets or rolls, as desired. Any size sheet can be printed, from the very smallest up to the maximum width of the machine, with equal facility, and prints can be made to any length in one piece. It is also possible to print any portion of a tracing without running the entire tracing through. The machine is rapid in its operation, and the light is such that prints of any kind can be made. These printers are also furnished in any width up to 54 inches, with lamps corresponding in number to the size of the machine.

SIBLEY STATIONARY-HEAD DRILLING MACHINE

The distinguishing features of the new stationary-head drilling machines with geared feed (the first lot of which the Sibley Machine Tool Co., South Bend, Ind., has just completed) are simplicity and rigidity. The design of the machine and the geared feed, adapt it to the heavy duty inci-



Sibley Stationary-head Drilling Machine

dent to modern manufacturing methods. While having the same range as similar models formerly made by this company, this machine, a view of which is shown herewith, is considerably lower in height.

It will be noted that the feed mechanism derives its power from the top driving shaft, and all the gearing is completely enclosed and runs in an oil bath. Four changes of feed and a neutral position are effected by moving the small knob seen in the center of the handwheel; the convenience of this arrangement is obvious. An automatic stop collar on the spindle sleeve, trips a latch at the desired depth of hole and the worm swings away from the worm-gear. This feed has been given unusually severe tests, and the results were so successful that it has been adopted for the entire line built by this company, excepting the 20- and 22½-inch sizes.

This machine will drill to the center of a 24½-inch circle. The maximum distance from the spindle to the base is 42½ inches, and to the table, 27 inches. The table has a traverse

on the column of 16 inches, and its diameter is 21 inches. The spindle has a feed of 9 inches, and the four variations range from 0.007 inch to 0.020 inch per revolution of the spindle. The diameter of the column is 7 inches, and of the spindle 1½ inch. The height of the machine is 6 feet 10½ inches and the net weight, 1400 pounds.

ALINER-BOSWELL RADIUS PLANING ATTACHMENT

Various attachments have been devised for machining the links of valve operating mechanisms to the proper curvature or radius, especially in locomotive shops where links frequently have to be machined. After a careful study of practically all these devices, the radius planing attachment shown in Fig. 1 applied to a planer was designed. It is built by H. B. Underwood & Co., 1024 Hamilton St., Philadelphia, Pa. In the construction of this attachment, the aim was to build a tool capable of rapid operation and one so arranged that wear would not affect the accuracy of the work.

This attachment, the construction of which is more clearly illustrated in Fig. 2, has a plate *A* which is fixed to the planer table and has integral with it a square projecting block *B*. This block fits into a cross slot in the ring *C*, which has an annular bearing in the top plate *D*. The latter forms the work table, and it is attached to a radial bar that passes through a double-trunnioned bearing mounted in an adjustable stand *E*. The ring *C* is kept down by a central plate, as shown, and the work table is provided with a retaining ring *F*. The movement of the planer table is transmitted by square projection *B* to ring *C*, which, in turn, imparts a circular movement to the work table; this is accompanied by a lateral movement of ring *C* with relation to the square driving block. With this arrangement the driving power is transmitted to the work table in the direction of the reciprocating movement of the planer, and the thrust of the tool's cut is also along parallel lines. Owing to the small amount of stress imposed on the radial bar, the latter is made comparatively light. This bar is of tubing and the attachment is adjusted for planing different radii by shifting stand *E* and its bearing along the bar at right-angles to the planer table. This radius attachment allows heavy cuts to be taken, and a link may be quickly located in the fixture by a center line marked upon the chuck.

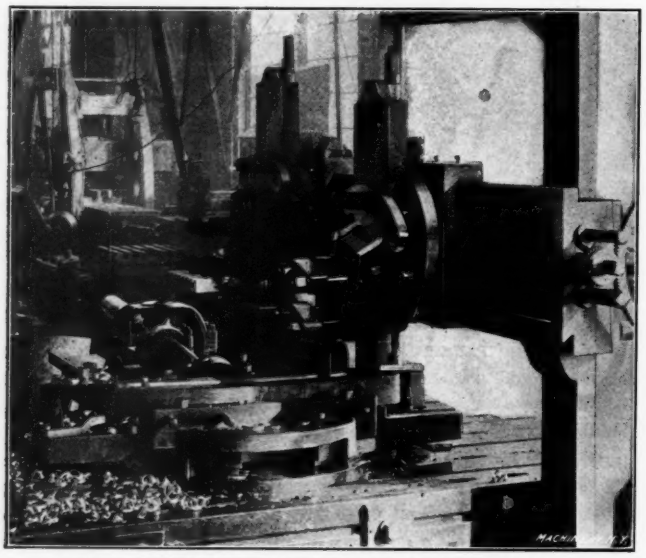


Fig. 1. Radius Planing Attachment for Machining Links, etc.

Prior to planing the curved slot, the sides of the link are planed, the edges milled, and the clearances for the planing tools, drilled and slotted. The work is then placed in the attachment and the slot is rough planed by using two parting tools simultaneously. These tools cut narrow slots on each side, and the central part of the slot is removed in the form of a solid block. This parting operation, including setting up the link and removing the block, has been done on a 15-horsepower planer in thirty-five minutes, the link being of hammered steel and 3½ inches deep. After the link is roughed out in this manner, the slot is finished by side tools. This attachment can also be used for planing quadrants, dies, curved stone, etc.

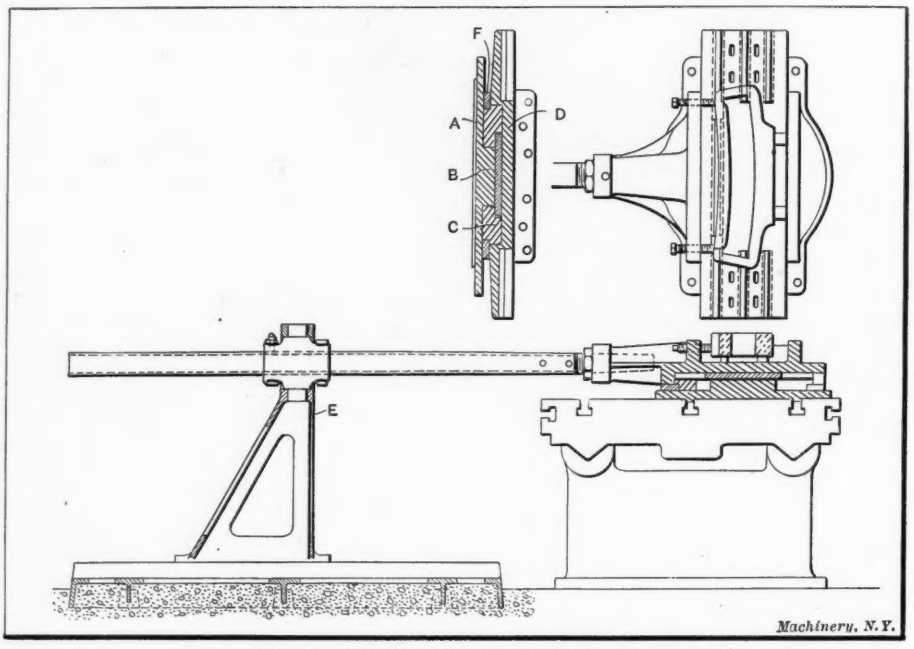


Fig. 2. Elevation and Plan of the Radius Planing Attachment

WATSON-STILLMAN HYDRAULIC PRESS

The small hydraulic press which we illustrate herewith was designed by the Watson-Stillman Co., 192 Fulton St., New York, for laboratory work and for crushing specimens of building material. This press is also useful in machine shops where small parts are press fitted, or where a high pressure must be brought to bear on any small article, whether for bending, straightening or flattening. It can also be applied to an endless number of odd jobs about any shop.

Small Hydraulic Press for Laboratory and General Shop Use

The convenient size permits the press to be mounted on a light truck and hauled from place to place. The ram is quickly traversed by the lever and connecting links shown at the left. The handle at the right on the extension lever

socket will operate the pump easily where only light pressures are required. By applying the extension lever, the press will develop a pressure of 30 tons. The platen is 8 inches square, the maximum opening is 8 inches, and the ram movement is 4 inches. The base measures 12 inches by 16 inches, and the height of the press over-all is 27 inches. The main cylinder is a steel forging, machined to fit perfectly into the reservoir, and the pump cylinder is of bronze. This press is designed to withstand severe service, and it is ideal for small work requiring high pressures.

EVANS AUTOMATIC TAPPING MACHINE

The Beaman & Smith Co., Providence, R. I., is manufacturing the automatic tapping machine, front and rear views of which are shown in Figs. 1 and 2. This machine, by making certain changes in the equipment, can be employed as a four-way tapping machine, a bushing machine, a union machine, or one for finishing valve bodies. The machine is changed for these various purposes by simply substituting a different front and head, the main body remaining the same.

The four-way machine is usually furnished with three heads, as shown in Fig. 1, for tapping L's, T's and Y's. For tapping crosses, one side is equipped with four heads, the extra head being taken from the opposite side. The work is held in a toggle-joint chuck which grips the fitting tightly. This chuck is of the floating type, to allow the taps to center themselves with reference to the rough cast holes. The chuck is mounted on a knee and it has both vertical and horizontal adjustments similar to a shaper table, which make it possible to tap return bends.

The bushing machine is suitable for all bushings except the face type, which can be handled to better advantage in the four-way machine. The special feature of this machine is an automatic chuck which opens, closes, and drops down for clearance, automatically. A plunger which operates the chuck holds the bushing and centers it. The union machines are of the same type, but the head, tail and nut are finished on separate machines differently equipped. Each part is finished complete in one chucking, and the work is accurate and uniform. There are no complicated tools, a hollow mill doing the work of reaming and facing, and a single tool the forming for the tail. The threads are all cut with leaders and Pratt & Whitney dies are used.

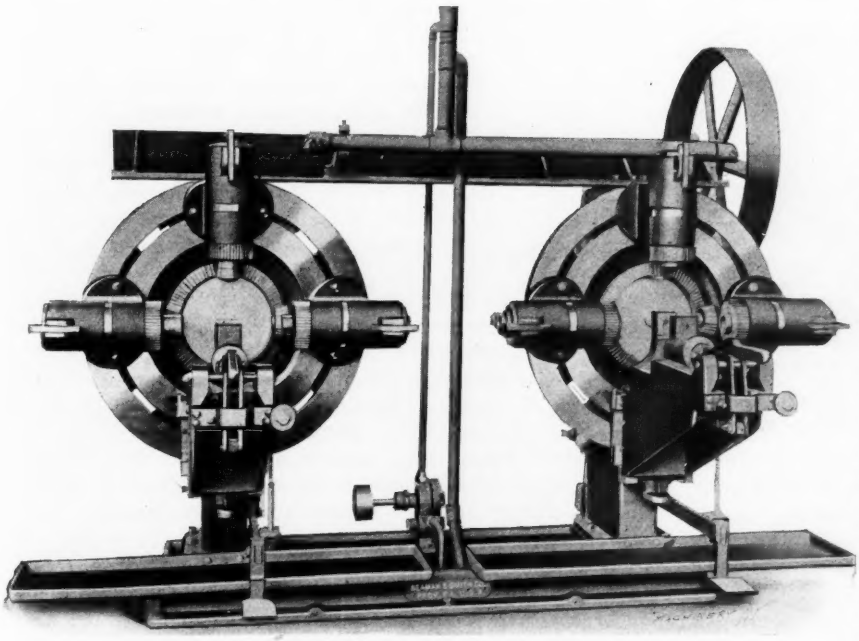


Fig. 1. Automatic Tapping Machine, built by the Beaman & Smith Co.

The valve machine finishes valve bodies in one operation. except the seat, which is done in a second operation on the same or another machine. This machine is identical with the four-way tapping machine, excepting the heads which carry the tap, reamer and facer, these being provided with compound spindles. The valve body is chucked in the usual way, and the taps and facer work simultaneously, so that the work of tapping, facing and recessing is finished in the time required for tapping. As the tapping and facing is done with one spindle, the faces are true with the tapped hole. The valves are also made uniform, as the spindles work to a positive stop. The tools required are one set of jaws, three taps, and three hollow mills.

Fig. 2 shows the driving mechanism, which is the same for the different machines. A horizontal shaft at the top connects, through bevel gears, with a vertical shaft in the rear which transmits the movement through a second set of bevel gears to a central gear in the front of the machine

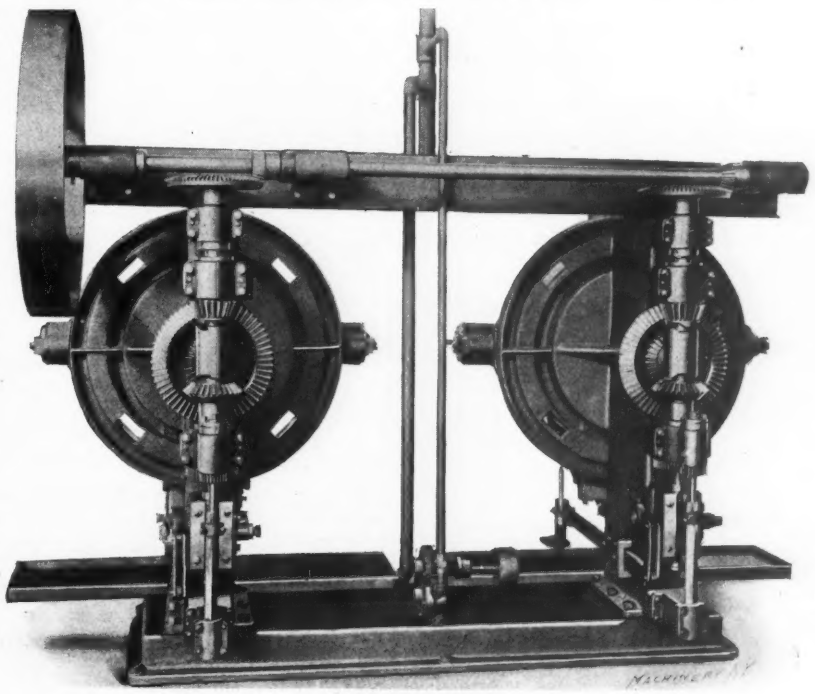


Fig. 2. Rear View of Tapping Machine, showing the Driving and Automatic Reverse Mechanism

which drives the various tapping heads. The small inner bevel gear in the rear is for the reverse speed, which is three times that used for tapping. The change from one speed to the other is effected by a clutch interposed between the driving pinions, as shown. This clutch is operated automatically for the fast reverse, by the mechanism seen near the base. This consists of a slide that is moved vertically by the spur gears and screw shown, until a dog on it comes in contact with an adjustable screw, which causes the clutch to shift from the regular driving pinion and engage the reversing pinion.

By means of the adjustment connected with this mechanism, the number of revolutions for tapping a fitting can be varied to obtain any desired length of thread. For example, a ½-inch fitting is usually tapped with nine turns of the tap, and three turns are added to give clearance. In this case the increased reversing speed would remove the tap in four revolutions. A patent tap-holder is used for these machines, which allows the cheapest forms of taps to be used. The tap is held by the thread, which insures accurate alignment. The jaws of the tap-holders are interchangeable, so that changes for different sizes can be quickly made.

On these machines the heads can be adjusted to any angle, permitting L's or T's of any degree to be tapped. Each spindle also has a separate leader which allows any pitch to be cut. This leader can be adjusted so that a fitting can be gaged within a quarter of a turn. Special spindles with dies are used

to cut nipple L's, nipple T's, or plugs. Pratt & Whitney dies are used, and a special feature of the spindle allows the die to be quickly replaced. A special head is made for cutting right- and left-hand L's.

After one of these machines is set and started, the operator can attend to others, as the machine stops automatically when the work is completed. The entire time for chucking the work and starting the machine varies from three to six seconds, depending upon the size and character of the work. The chucking is effected by a single motion of each hand, and while this is being done, an automatic lock prevents the foot lever by which the machine is started from working, thus eliminating any danger of accident. The operator is further protected by cast-iron guards that are provided for gears, clutches and other dangerous parts.

The four-way tapping machines are built in 1-, 2- and 4-inch sizes; the bushing and union machines in 1- and 2-inch sizes, and the valve machines in 2-inch size.

GANG SENSITIVE RADIAL DRILL WITH ALL-BELT DRIVE

The radial drilling machine illustrated in Fig. 1 has been designed by William E. Gang Co., Cincinnati, O., for driving high-speed twist drills ranging from ¼ to 1 inch in diameter, at their maximum efficiency. As this machine has an all-belt drive, with no gears whatever in the transmission, it is practically noiseless, even when operated at high speeds.

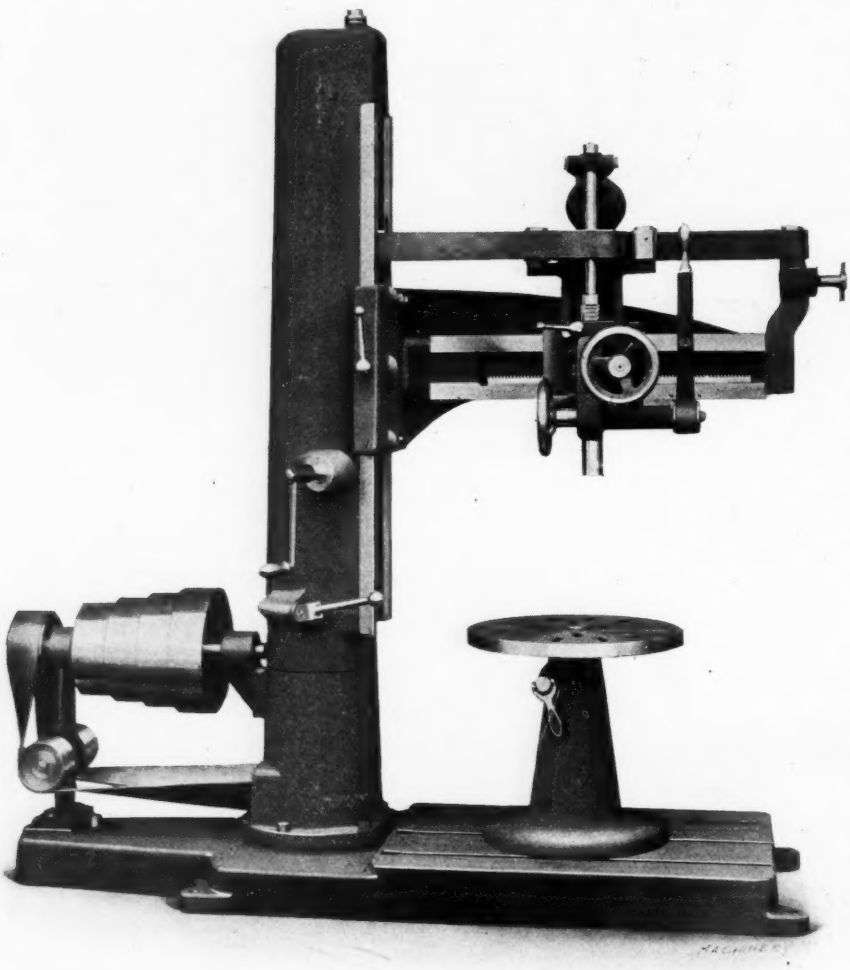


Fig. 1. Gang All-belt-driven Radial Drilling Machine

The power is transmitted from a cone-pulley at the rear, by a belt which connects with a vertical shaft inside the column. This vertical shaft, which extends the full length of the column, is splined to a pulley carried by a bracket extending in the column from the radial arm. From this pulley the power is transmitted by a horizontal belt to the spindle. This belt is so arranged that it encircles half the circumference of the spindle pulley constantly, and it has the same tension irrespective of the head's position. This tension is maintained by the position of the idler pulleys and without resorting to springs or counterweights. These idler pulleys are so located with reference to the spindle pulley that the driving belt has an equal contact on both sides of the spindle pulley, which exerts a balanced pull without lateral strains on the spindle annular ball bearing. Provision is made for taking up the slack of both belts due to stretching.

All running parts are in accurate running balance, and are carried on imported annular ball bearings. The mounting of these bearings was given much thought and attention, the arrangement being such that no running part rides upon a stationary part, the ball bearings taking all radial and thrust loads, thus reducing friction to a minimum. The ball bearings are encased to protect them from dust or injury, and they require lubricant only at long intervals. This machine has driven a ½-inch high-speed drill, running 900 revolutions per minute, through a 2-inch cast-iron plate, at the rate of 25 inches per minute, with a feed of 0.028 inch per revolution of the spindle, and drills of other sizes in proportion.

A two-speed friction countershaft, in conjunction with the four-step cone, gives eight spindle speeds, which vary in geometrical progression from 300 to 1170 revolutions per minute, giving an average velocity of 80 feet per minute for drills ranging by sixteenths from ¼ inch to ⅝ inch inclusive, and by eighths from ½ inch to 1 inch inclusive. This speed has been found to give good results under average shop conditions, but, if desired, the countershaft can be speeded up to give the highest speeds that modern twist drills will stand.

The spindle of this machine can be rapidly traversed by a handwheel at the left of the head, and it is fed by the lever shown to the right. This lever has a ratchet so that it can be placed in the most convenient position for drilling. When the lever is turned to a vertical position, the latch automatically locks it and prevents it from falling, but this does not release the spindle from the control of the lever. In other words, the same relative position of the lever to the drill point is maintained, thereby avoiding the necessity of resetting it for each hole, when a number of holes are being drilled in the same plane. By pushing the lever slightly beyond this first position of the locking latch, into another notch, the spindle is released from the control of the lever so that it can be moved up or down by the handwheel. The counterweight directly connected to the top of the spindle makes the lever feed extremely sensitive.

The weight of the column is taken by a conical roller bearing, and the column is clamped by a quick-acting cam-lever, which, by the aid of a hexagon nut and draw-bolt, can be made to clamp in any position found convenient by the operator. The arm is very rigid, being made in D-section and strongly webbed. It is raised and lowered by a crank at the side of the column which connects, through bevel gears, with an elevating screw that engages a stationary nut bolted to the arm. The thrust of this screw is taken by a ball-thrust bearing. The arm is clamped by the ball-lever shown. The head or saddle is moved on the arm by a handwheel operating through a rack and pinion, and it can be securely clamped in any position.

This machine is also furnished with a tapping attachment shown in detail in Fig. 2. Like the drive of the machine proper, no gears are used in connection with this attachment, the spindle being reversed by a narrow belt located above the spindle pulley. This belt is driven from the idler pulleys on the head (which revolve in an opposite direction to the main driving pulley), and it drives a pulley supported on a plate directly above the main pulley. Between these upper and lower spindle pulleys there is a cone-clutch operated by

the bent lever seen to the right of the spindle. This clutch is normally held in engagement with the forward or lower pulley, by a powerful self-contained spring, thus causing the spindle to run forward. When a reverse movement is desired, the clutch is disengaged from the lower pulley and engaged with the upper or reversing pulley, by the lever referred to. As soon as this lever is released, the spring automatically withdraws the chuck from the reversing pulley, and engages it with the forward pulley. An adjustable idler is provided for taking up any slack in the belt due to stretching.

The salient features claimed for this tapping attachment are as follows: It operates without shock or jar at speeds as high as 1170 revolutions per minute; it reverses instantly; is absolutely noiseless in operation; and the spindle alone reverses so that the machine is equally sensitive for both drilling and tapping operations. The tension of the belt can also be readily adjusted so that it will just pull any size tap, thus permitting the tap to be driven into a "blind" hole and to strike the bottom, without danger of breaking it

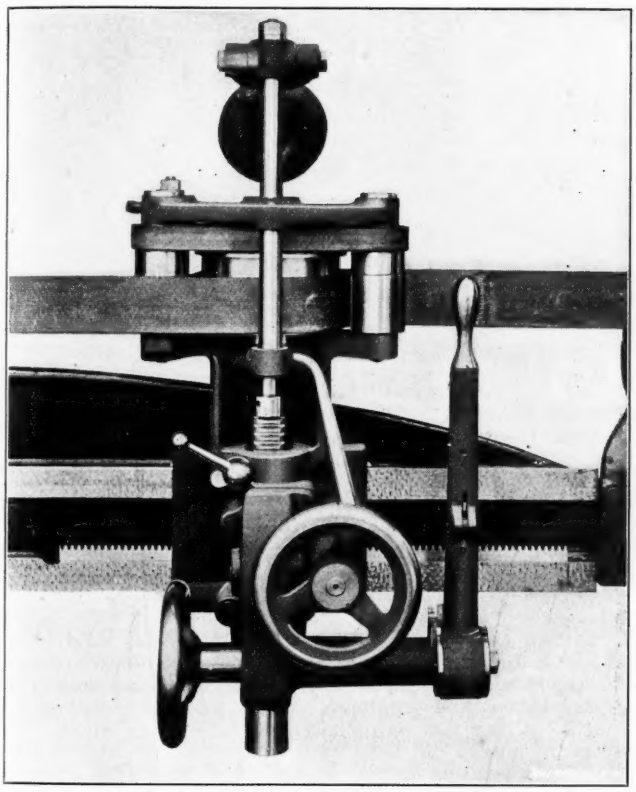


Fig. 2. Tapping Attachment for Gang Radial Drill

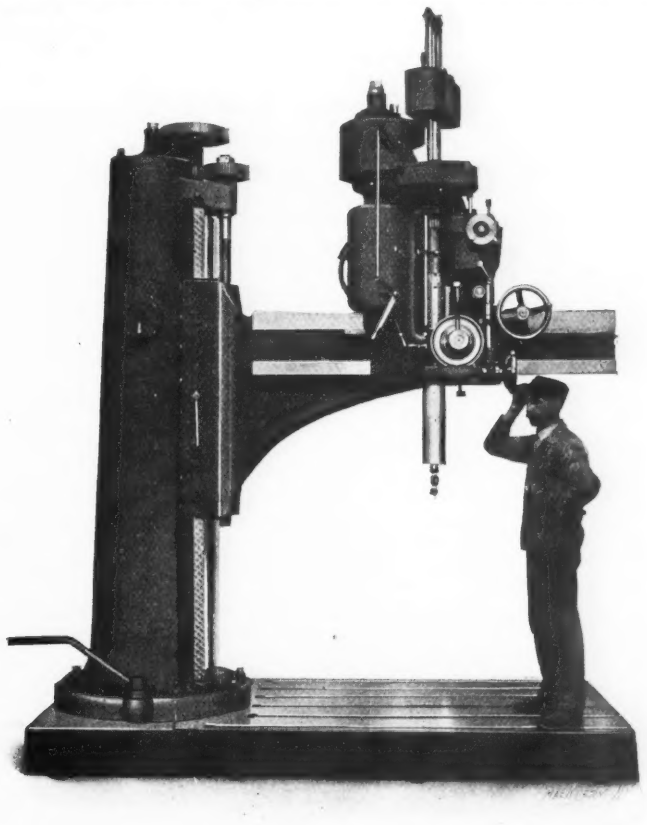
or injuring the machine. This machine will pull U. S. standard taps up to and including ¾ inch. The arms are made in 2½-, 3- and 3½-foot sizes. The standard equipment includes belts and a plain round table, as illustrated. Other styles of tables can also be furnished.

ELECTRICALLY-DRIVEN RADIAL DRILLING MACHINE

The large radial drilling machine shown in the accompanying view is a recent design built by the James Clark, Jr., Electric Co., 520 West Main St., Louisville, Ky. This machine has a maximum distance of 72 inches between the spindle and base of the column, and it weighs, complete, 19,000 pounds. It is electrically driven, and the driving motors are incorporated in the design, making the machine compact and substantial.

The motor for driving the spindle is a variable-speed type, having a 4 to 1 speed variation, and it will develop a maximum of fifteen horsepower. Twenty spindle speeds are obtained through one back-gear and the motor changes. The friction back-gears can be changed without stopping the machine, and all operating handles are conveniently located. The driving and feed gears are all of steel. The spindle has a vertical traverse of 19 inches, and its smallest diameter is 3 inches.

The hoist motor for the arm is mounted on top of the column, and either upward or downward movements are obtained by throwing the controller handle shown on the side of the column, to the right or left. The column turns on ball and roller bearings, and when the clamping lever is tightened, the large flange at the base of the column is drawn down into contact with the bed, thus binding it rigidly. The arm has long gibbed bearing surfaces on the column, as the illustration shows. When adjusting the arm vertically, the



Radial Drilling Machine, built by the James Clark, Jr., Electric Co.

hoisting motor shows no difference in the power consumed with the head close to the column or at the extreme end of its traverse.

While this machine was being tested, thirty-five holes were drilled with a 1⅞-inch high-speed drill in twenty-five minutes through two steel condenser heads clamped together and having a total thickness of 2 inches. The actual drilling time for each hole was thirty-five seconds. This machine has a total height of 114 inches, and the bed measures 117 by 54 inches.

NEW MACHINERY AND TOOLS NOTES

Forging Machine: Ajax Mfg. Co., Cleveland, Ohio. Upsetting and forging machine which is said to be the largest ever constructed. The construction of this machine, which is a 7-inch size, is similar to the standard line of forging machines built by this company.

Drill: A. C. Vauclain, 401 North 33rd St., Philadelphia, Pa. New type of twisted drill with cutting edges which meet in the center thus eliminating the scraping action common to the web point of a regular twist drill. Tests are said to show a very low power consumption.

Pipe Cutting and Threading Machine: Curtis & Curtis Co., 8 Garden St., Bridgeport, Conn. Electrically-driven pipe cutting and threading machine. The die cutting head is of the Forbes pattern and has a range of from 1 to 8 inches. The machine has a cabinet base which contains the driving motor.

Duplex Milling Machine: Becker Milling Machine Co., Hyde Park, Mass. This machine is of the Lincoln type, the table of which has a working surface of 11 by 40 inches. The spindle heads are independent and have micrometer adjustment. The spindle speeds range from 15 to 38 revolutions per minute.

Combination Drill: Standard Tool Works, Standish, Maine. Combination drill having a small pilot drill to relieve a center of larger size, the same as when a small hole is first drilled for this purpose. The pilot drill has a taper shank which is inserted in the end of the large drill, the latter acting as a socket.

Combination Screw Driver: J. C. Barrett Co., Hartford, Conn. Combination screw driver set with blades that fold within the handle similar to a jack-knife and are retained by a knurled sleeve at one end. These blades are of different sizes and a quarter turn of the retaining sleeve enables any one to be quickly brought into the working position.

Quick Return for Horizontal Boring Mill: Cleveland Machine Tool Works, Cleveland, Ohio. Quick return for horizontal boring mill cutter bars which is effected by operating a pilot wheel on the head after pulling out a knob conveniently located in its center. This arrangement facilitates the operation of the machine and will be applied to the line built by this company.

Castellating Fixture: Hendey Machine Co., Torrington, Conn. Nut castellating fixture consisting of a circular plate having projections that prevent the nuts from turning while slots are being milled. Three passes of the gang cutters are necessary to castellate a plateful of hexagonal nuts. The work-holding plate is attached to a base by swinging bolts and it can be quickly indexed.

Steel Clamp: Adell Bros. Mfg. Co., Orange, Mass. Pressed steel clamp made from sheet steel and designed for the use of machinists, toolmakers, etc. The screws are long and have special U. S. standard threads that are fine enough to insure a powerful clamping action. The standard sizes have 6-inch jaws with a 4½-inch opening; 7⅜-inch jaws with a 5½-inch opening; and 8¾-inch jaws with 6½-inch opening.

Milling Machine: Becker Milling Machine Co., Hyde Park, Mass. Vertical belt-driven milling machine designed for doing an average line of work without the use of spindle gears. The machine is driven by a 5-inch double belt and has sufficient power with the open belt drive to take cuts ranging from 1/16 to 3/32 inch deep in cast iron, with a table feed of 8 inches per minute, using surface mills 10 to 12 inches in diameter.

Cold Saw: Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa. Cold sawing machine having an annular disk blade with internal teeth. The saw has a positive direct-geared drive, and the power is furnished by a 20-horsepower motor. Nine changes of feed are obtained through a gear box, and there is a reversing rapid power traverse. This saw is rated as a 5-inch machine, but it will clear diameters up to 7 inches.

Cutting-Off Machine: Hurlbut-Rogers Machine Co., South Sudbury, Mass. Five-inch self-contained motor-driven cutting-off and centering machine of the accelerated-speed type. The centering attachment is driven from a short shaft under the main spindle, having a sliding gear at one end which meshes with one of the driving gears of the machine. This attachment is mounted on a sliding base and can be moved out of the way when not in use.

Circular Milling Attachment: Hendey Machine Co., Torrington, Conn. Circular attachment applicable to the No. 3 and 4 milling machines built by this company. The table has a power feed in either direction controlled by a lever which may be placed in a neutral position when it is desired to turn the table by the handwheel provided. The diameter of the table is 20 inches and it is graduated in degrees. The attachment can be quickly removed, when not in use.

Test Indicator: E. M. Erb Mfg. Co., Jersey City, N. J. Dial test indicator adapted to general shop and tool-room work. The dial face is covered with celluloid, and the indicator spindle has a shoulder which prevents accidentally forcing it in too far and injuring the mechanism. These indicators are subjected to rigorous tests for accuracy, and the mechanism is compact and simple. A means of adjustment is provided, if for any cause this should be necessary.

Chuck Mechanism: Adolph Muehlmatt, Cincinnati, Ohio. Chucking mechanism for engine and turret lathes, bench lathes, etc. The arrangement is such that the work can be gripped by the chuck, machined and removed without stopping the spindle. The chuck is actuated by a closing tube inside the spindle which derives its movement from a lever located at the front or rear of the head, the position depending on the type of machine. These chucks are made for gripping work either internally or externally.

Planimeter: W. L. Durand, 929 K St., N. W., Washington, D. C. Radial planimeter designed to give the mean value of the ordinates of circular charts, such as are used for recording pressure, temperature, etc. The instrument is graduated to give the mean ordinate in linear inches, so that by applying the appropriate scale factor, it may be used for all diagrams, regardless of the character of the quantity recorded. The tracing point of the instrument will cover circles ranging in diameter from 1½ inch to 10½ inches.

Gasoline Engines: Trump Bros. Machine Co., Wilmington, Del. This company has placed on the market a line of two-cycle marine gasoline engines. In designing these engines it was the aim of the builders to make a simple, reliable and efficient motor. All parts are easy of access and special attention has been given to the matter of lubrication. The cylinders, crankshaft, and all inside moving parts are positively oiled from one source. These engines are made with single or double cylinders and in sizes ranging from 3 to 12 horsepower.

Special Turret Machine: Pottstown Machine Co., Pottstown, Pa. Multiple-operation turret machine built specially for the production of globe valves. This machine can, however, be used for a variety of work by changing some of the equipment. It will handle globe valves varying from ½ inch to 2 inches inclusive, and will finish ½-inch brass valve bodies at the rate of six per minute and 2-inch bodies at the rate of four per minute. The machine is so arranged that it is impossible for the operator to move the turret until the automatic gripping device is released.

Precision Lathe: Rivett Lathe Mfg. Co., Brighton, Mass. Precision bench lathe equipped with a device for correcting any errors in the lead-screw when it is desired to cut very accurate threads. This device consists of a bar that is mounted in bearings at the back of the lathe bed and connected with the lead-screw at the front. This bar has an arm attached to it engaging an adjustable slide, which, by its angular position, governs the compensating movement of the lead-screw. This attachment is also useful for giving slight variations in the pitch of threads when necessary.

Automatic Metal Saw: Covel Mfg. Co., Benton Harbor, Mich. Automatic circular, metal saw sharpener that can be used to retooth or punch heavy circular saws without retempering. This machine is provided with a patented crosshead which enables the center of a saw to be adjusted to coincide with the grinding wheel center at all times. The machine can be used for grinding new teeth in saws where the old ones have been broken, and the work can be fed to the emery wheel by an index plate. All adjustments of rods or connections are controlled by handwheels and screws, and adjustments can be made with the machine running.

Bending Machine: Wallace Supply Co., 108 North Jefferson St., Chicago, Ill. Hand-operated bar bender, especially designed for bending the reinforcing bars used in concrete work. Stock 1¼ inch in diameter can be bent cold without difficulty. Either round or flat material can be handled, and by substituting higher dies, flat stock 4 inches or more in width can be formed. The power is obtained by a 36-inch ratchet lever which operates a small pinion meshing with a stationary segment gear. By turning the pinion along this gear, a radial member carrying the bending jaws is given the required movement. This machine is furnished with or without a stand.

Boring and Turning Mill: Betts Machine Co., Wilmington, Del. Boring and turning mill designed for heavy duty. The faceplate is driven by two pinions located on opposite sides which tends to give smooth operation. The machine swings 20 feet 3 inches and will take work 12 feet in height under the tools. A fine tool adjustment on the saddles enables the operator to adjust the tools either vertically or horizontally to the exact position required after they have first been located approximately by the rapid traverse. The tool spindles are balanced directly on the swivels by means of cast-iron rings which slide on tubes attached to the swivels. The total weight of the machine is 373,000 pounds and it is driven by a 50-horsepower variable-speed motor.

Multiple Injector Sand Blast: J. M. Betton, 178 Washington St., New York. Multiple injector sand blast designed particularly for foundries having a large output. The sand is contained in a vertical tank capable of withstanding a pressure of 80 pounds per square inch. The outlets are attached to the bottom of the tank and the flow of sand is regulated by a valve so designed that it will not jam under the sand pressure. The sand is thoroughly mixed with the air in the sand blast apparatus and it is discharged through a rubber hose and nozzle. The flow of sand through each outlet can be regulated or stopped independently of the others. These sand blasts are made in capacities varying from 2000 to 16,000 pounds of sand, and with from one to four outlets.

Multiple Drilling Machine: Moline Tool Co., Moline, Ill. This machine is of the independent spindle feed type and can be equipped with any number of heads desired. It has six changes of speed by 3-step cone and back-gears. The drive is the company's standard double spiral type, the main spirals in the rail being of steel and the spindle spirals of phosphor-bronze. The spirals and the spindles are all equipped with ball thrust bearings. The spindle feed is by Sellers' motion, a bronze spiral working in rack teeth cut in the steel quills, which are bronze bushed. The bronze spiral mounted on the inclined shaft which also carries the quick-traverse handwheel, is driven by bronze and hardened steel worm-gearing. This shaft is pivoted so that the worm-wheels may be dropped out of mesh with the worms either by the hand latch or by the automatic stop. The spindles do not run directly in the heads, but in revolving sleeves on which the spindle spirals

are mounted. The lower bearings of these sleeves are adjustable for wear. The spindles are counterbalanced. The closest adjustment of the spindles is 6 inches, and the travel 10 inches. They have a No. 5 Morse taper and the capacity is up to 2 inches.

* * *

THE OXY-ACETYLENE PROCESS AND THE STEEL CAR

It is not so many years since the first steel freight car was built; to-day, it is the highest type of construction and is in general use on the best railroads. The steel passenger coach is still a novelty, although it is evident that it has come to stay. Three principal problems have arisen in connection with these developments: (1) the making of a strong joint;

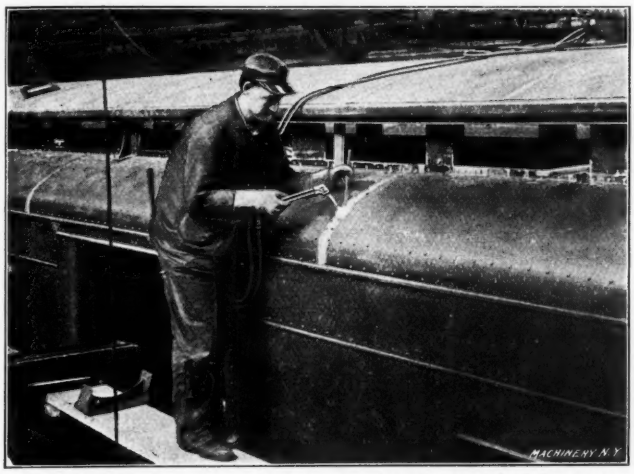


Fig. 1. Welding the Lower Deck Roof by the Oxy-acetylene Process

(2) making this joint invisible; and (3) the performance of the work by a method which would involve only the parts in the immediate neighborhood of the joint. The great strength of the riveted joint has made it a favorite in many locations on the steel car; but the riveted joint is not invisible. Brazing is sometimes used with success, but it has two great objections: (1) weakness of the metal united; and (2) a different coefficient of expansion.

The new process of "welding" by the oxy-acetylene process seems to afford a very practical and economical solution, for the joint has from 80 to 85 per cent of the strength of the steel, can be made invisible, and the effects of its application are local. On coaches for one railroad, the joints of the roof plates, Fig. 1, usually made of from 1/16- to 3/32-inch metal,

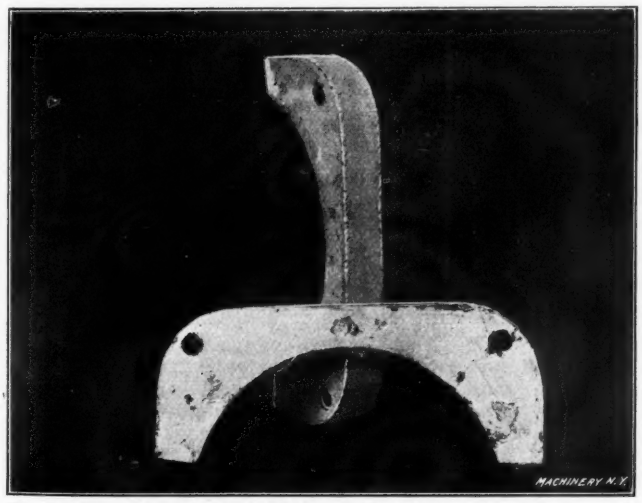


Fig. 2. Lamp Supports located between Head Lining and Roof. Formerly made in Six Operations on the Power Press

are being closed by the oxy-acetylene torch. On a standard car, the roof joints have a tendency to bend downward and form a groove with the joint at the bottom. This tendency is successfully dealt with by using a little T-bar, to the web of which the plates are riveted, the oxy-acetylene process effecting a waterproof closure. The T-bar so increases the capacity for heat absorption that a heavy ⅛-inch wire is used, but it is not necessary in butt welding such thin sheets to chamfer the edges. Conditions vary on different parts of the roof, but a flat labor rate of 4 cents per lineal foot is paid, while the gas expense is about 1½ cent, making a total for the entire roof of about $12.75.

Another example of welding on steel coaches is found in the joints of the flat longitudinal panel frieze along the side of the car molding above and below, made in three sections of 1/16-inch metal. The separate pieces are straight, but the joints are so arranged as to give the center an arch of ⅜ inch in the 60-foot length, to provide for spring when under load. This severely tests the joints. Formerly the joint was made by brazing, which is not only quite expensive but also gives a weak joint. By the oxy-acetylene process, a much better job is produced at about half the cost. In making the weld, work is begun at a point one-third its width from the side which is to be uppermost when located, welding this upper third which forms the camber in the wrong direction. However, by beginning at the same point and welding the remaining two-thirds, this negative camber is eliminated and the correct one introduced. The plates are held together by the weld alone and the joint on the completed car is practically invisible.

Diamond-shaped window frames used on some coaches, which are made of 3/32-inch plate and have four mortised joints each, are jointed by oxy-acetylene welding. Similar joints in the rectangular deck frames of other cars are also welded by the same process; in a single car, there are upward of 176 such joints, or about 30 lineal feet of welding. In a certain construction, the ventilator frames have a cast-iron fitting which is attached interiorly to each upright. A bolt and nut do not insure a solid attachment, but with the

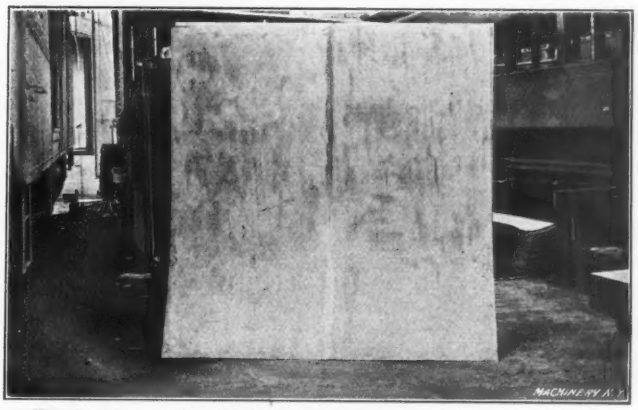


Fig. 3. Piece of Head Lining made of Patent Level Stock, joined by Oxy-acetylene Welding

oxy-acetylene welding process, the gray cast iron and the hot rolled plate are readily and firmly bound together.

Another example of welding as a finishing procedure is in connection with the grab handles, which consist of a steel tube and two fittings. The fitting when in position has a vertical projection which is enveloped by the tube end, a countersunk pin holding the two firmly together. The welding process is used to efface the joint where the end of the tube comes in contact with the shoulder on the fitting, the labor cost of setting and welding these fittings being 1½ cent each, or 3 cents per handle.

An interesting application is the making of a kind of support, Fig. 2, used on certain coaches. In these cars, the roof sheets and the steel head lining are about 1⅞ inch distant, and are strengthened at the chandeliers by inserting the box-like support shown, two for each lamp. Each piece is of a rather complicated sheet-metal form, and was formerly made by pressing, in six operations, but as there was a large percentage of failures through radial cracking at the bends, they are now formed from three pieces of 3/32-inch sheeting through the oxy-acetylene process. The estimated saving is 50 per cent, with practically no failures.

It is practically impossible to form the complicated depression at the bottom of the recess for the water cooler used for drinking purposes, in conjunction with the bottom of one piece by the use of the press, although the depressed piece apart from the bottom of the alcove can be so formed. The

welding process is used to unite the pressed piece and the bottom, also uniting the bottom to the vertical part of the alcove.

Perhaps the most interesting piece of work is the welding together of sheets to form the seven-foot square units of head lining, shown in Fig. 3. This patent level stock is not obtainable in sufficient width, so, by the use of the oxy-acetylene welding process, two strips are so united as to produce the desired piece without destroying the required flatness. The stock used is about 1/16 inch thick and no reinforcing strip is employed. In carrying out this operation, the two half-sheets are secured edge to edge on a suitable table by heavy bars properly clamped. The edges of the sheets are not prepared, but they are placed in contact on one side and perhaps ¾ inch apart on the other. The operator begins on the side where there is contact, using a No. 4 tip and 1/16-inch wire. At first, the separation of the opposite edges tends to increase, but as the work advances, they press toward each other. Two or three times during the operation the clamps on the open side are loosened and the edges permitted to approach a little. As the operator works across the 82-inch seam, a buckle follows, but this disappears as the weld is finished. Straight ends may readily be obtained by trimming, and the rough surface of the weld is remedied by filing. The expense for the labor, including the filing, is 4 cents per lineal foot, and the gas expense may be taken at 1½ cent, so that the weld costs, altogether, about 38.5 cents.

The Davis-Bournonville Co., 97 West St., New York, manufactures the apparatus used in the operation referred to; this includes torches and the generators of oxygen and acetylene.

* * *

DISK GRINDING ALUMINUM CHAIN-CASE CASTINGS

During a recent test in the experimental department of the Gardner Machine Co., Beloit, Wis., on the grinding of aluminum, the four castings which form the aluminum chain-case

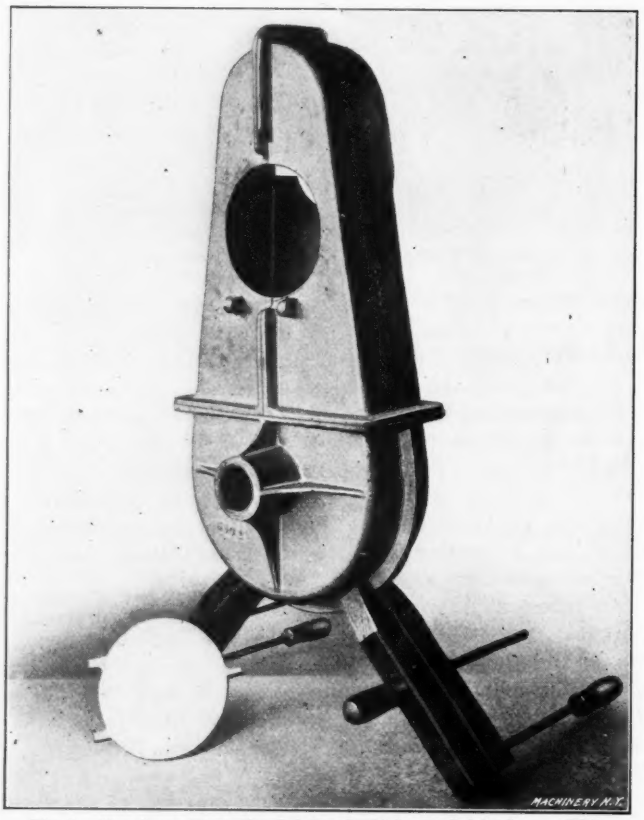


Fig. 1. Aluminum Case, the Joints of which are finished on a Disk Grinder in about Twenty Minutes

illustrated in Fig. 1, were finished complete in a little less than twenty minutes. The assembled case measures approximately 24 inches long; the maximum width is 11 inches, and the depth about 6 inches. Each of the four castings has two faces which must be ground flat, to size, and at 90 degrees to each other. The two adjoining faces of the bottom half of the case were first ground; they were then clamped together with patternmaker's clamps, and the top surface of this bottom half was finished. The two adjoining faces of the top half were next ground, and, after being clamped together, the bottom surface of the top half was ground.

In finishing these three joints in the time specified, it will, of course, be understood that the grinding was done from the rough casting. The time required for grinding the round cover shown in Fig. 1, was less than one minute. The re-

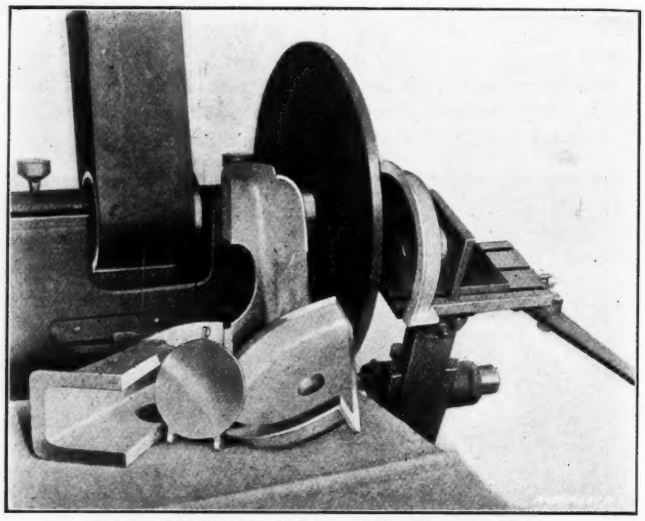


Fig. 2. Grinding the Sections of the Aluminum Case

sults of this test are particularly interesting, as these castings were formerly finished on milling machines and about ⅛ inch stock was left for machining. When the disk grinder is employed, from 1/64 to 1/32 inch has been found sufficient for finishing. It has been estimated that this difference in weight would pay for the grinding, making the finished case, when disk ground, cost less than the rough casting when the required stock is left for any other method of finishing.

It is the practice of this company when disk grinding aluminum, to use soft metal wax in connection with the abrasive disk. When this is not done, the chips have a tendency to clog the disk which, of course, would in a short time lose its cutting efficiency.

* * *

COMMERCIAL SECRETIVENESS

At the recent "Congress of Technology," held in Boston to celebrate the fiftieth anniversary of the Massachusetts Institute of Technology, Prof. William H. Walker made a strong appeal to manufacturers for a more generous publication of the results obtained in modern industrial research laboratories, the reasons for his contention as to its desirability being given in the following:

"There is a heavy moral obligation on the part of large industrial organizations having fully equipped research laboratories to contribute their share to the advance of the world's knowledge. There is in every laboratory much work which could be published and yet conserve the interests of the corporation. First—there are the results which may not have proved valuable to the laboratory in which they were obtained, but which would be of immense value to some one else working in an entirely different field. Second—there are those results of value to the laboratory possessing them, but which could be published in an unapplied or 'pure' form, and which would be an important contribution to science, without causing the least injury to the company or corporation most interested. And finally there are those results of operations and processes, machines and apparatus, which, if the truth were known, are possessed by a number of concerns, but are held as valuable secrets by each. Every one would profit and no one be the loser by so far-sighted and generous a policy. It requires no extensive mathematical calculation to prove that the manufacturers themselves would be the ones to profit by such a liberal treatment of the results of scientific work. Of one hundred manufacturing concerns, each one would give but 1 per cent to the whole fund of information, while it would receive the remaining 99 per cent. It could not in the long run be the loser."

* * *

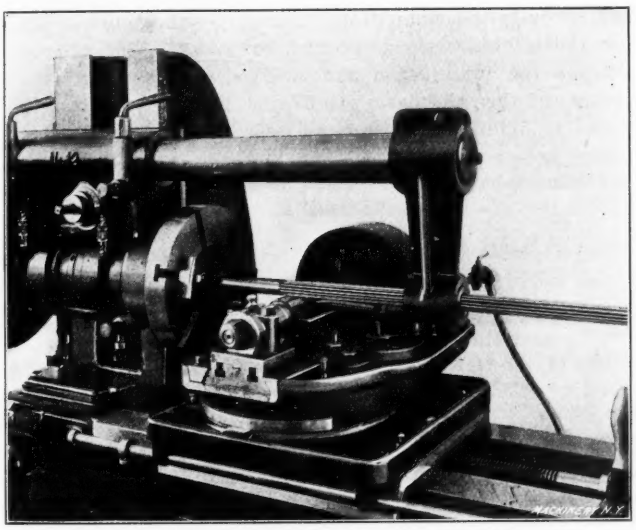
According to the *Scientific American* there is a movement on foot in France to have poles carrying high-tension current electric cables painted with some distinctive color, so as to act as a warning.

AN UNUSUAL GEAR-HOBBING SITUATION

By A WESTERN FOREMAN

One of those out-of-the-ordinary problems that are the spice of life in the humdrum of ordinary machine shop operations recently presented itself in an unusual gear-cutting proposition. The work in question was a 16-tooth pinion, 6 feet long and 1⅛-inch outside diameter, as shown in the halftone. Just how this pinion was to be cut seemed to be a problem impossible of solution, and about the only suggestions that were made were along the line of how the draftsman should have made his design so as to avoid this seemingly impractical pinion. However, work had progressed too far on the other parts of the machine of which it was a member, to allow of any change in the design, even if desirable.

The milling machine was first considered, but the largest machine at hand would not take work longer than 3 feet between centers, so that it could not be cut on the centers of the index head. The only feasible suggestion gleaned from a canvass of the practical heads of the plant was to rig up a planer with index centers and plane the teeth with a form tool. It was decided that this was the only way out of the difficulty, but it so happened that the planers were, at that time, very busy, so the job was laid aside until an opening



Cutting a Long Pinion on a Barber-Colman Gear-hobbing Machine, using a Special Chuck and Bushing

would occur. The job became the pet problem among the boys, all trying to think up a good scheme.

A Barber-Colman hobbing machine had recently been installed, and the new operator became so enthusiastic over the hobbing process, and was so much "taken up" with the possibilities of the machine that he naturally could see no other way of cutting gears. He also was interested in this job, and after careful consideration, offered to cut the pinion on his machine. The offer was finally accepted, and the manner in which he succeeded is the object of this article.

The machine is of the horizontal spindle type, with a 1⅛-inch hole through the work spindle, making it possible to run the pinion blank through the spindle, which was obviously necessary on account of the great length. The possible length of cut was about 12 inches, so that the work required shifting at least six times. To maintain the relation with the hob when shifting, the pinion blank was splined the whole length, with a 16-pitch gear-cutter on a milling machine, in the usual manner, shifting once or twice as necessary. In this way a straight guide was obtained by which the blank could be shifted and still maintain an accurate relation with the index wheel of the hobbing machine. To facilitate this, and also to act as a driver, a block about 3 by 1½ by 10 inches was made, with a reamed hole through the center of the flat side to fit the pinion blank, fitted with a key, the latter being made to fit the spline in the blank so as to allow of no play. A set-screw was provided to securely hold the blank after setting. The illustration shows the whole clamped to the faceplate as when used. The outer support was provided with a bushing in which the blank fitted snugly. To complete the work including the fixtures necessary, less than one day's time was required.

The horizontal arrangement of the machine was what made it possible to do this job, as in this way a pinion of any length could be cut if sufficiently small to pass through the spindle, the outer bearing providing a good support. The success with which this pinion was cut brought out a number of schemes for attachments that would automatically shift the blank or provide a continuous feed to the blank so that shifting would be unnecessary.

* * *

STANDARDIZATION OF AUTOMOBILE PARTS

The Society of Automobile Engineers, with a membership of about 800 engineers and experts connected with the automobile industries, has within a year accomplished results that will be found to have made engineering history, for it has made a very extensive forward movement in the standardization of automobile parts. That standardization is a good thing is realized by many, but the necessity of it would strike many more if the situation were thoroughly understood.

Few realize the multiplicity of designs that there are for some of the simplest details around automobiles; for example, there are from three to four hundred more dimensions and designs than there ought to be for lock washers between the sizes of 3/16 and ½ inch. The explanation of this unnecessary situation is very simple: it is due to the draftsman exercising his own judgment with regard to the various details, not having any standards from which to design the new part. He may choose a tubing for the steering cross-rod, for example, that does not exist in stock, or if there is not a table of tubing sizes before him, it is made to suit his own fancy so long as it will satisfactorily perform its functions. The same condition exists for the shapes of the heads of screws and bolts, and for the size of the holes, for the spring clips, and for many other details.

The errors due to the designer selecting non-standard parts cannot be checked until it is too late to do so, for when the drawing is completed, if the figures correspond and the design be a good-looking one, the checker passes it and it goes to the purchasing department, the parts being ordered. Here is where the trouble arises. The company from which the parts are ordered will have to perform special work in producing parts that are not standard, and in this way the cost is in many cases doubled. The worst feature of it is that the next time a new model is designed it may be desirable to incorporate this axle, or parts of it, to save tools and fixtures. This process is repeated, and it may be several years before the extra expense due to obtaining special parts is eliminated. All this arises, not from necessity, but from the unguided idea of the draftsman.

Standardization will not be an attempt to throttle original design, for there is not the slightest danger that this would ever be accomplished, even if attempted; the parts proposed to be standardized, such as screws, lock washers, spring parts, bearing parts, water connections, and many other small pieces too numerous to mention, would have no possible gain in originality if designed to meet the individual requirements, so that this useless multiplication of parts might well be minimized.

The aim of the society will be to put into the hands of every designing draftsman an engineer's pocket-book or a series of sheets which will show him what is available in these minor parts which have been standardized. This system already exists in constructional work, such as bridge building, and has been brought about by the large companies who furnish the materials. The handbooks which they publish show all the standard sections of structural shapes and the draftsman has formed a habit of going to such books to find out which size of any particular shape he can obtain having a regular section. He thus manages to incorporate such a standard piece in his design, with the result that no special rolls have to be made. The Society of Automobile Engineers stands ready to assist in manufacturing-difficulties in any of the many competent engineering fields of automobile production.

N. M. T. A. ANNUAL CONVENTION

The thirteenth annual convention of the National Metal Trades Association was held at the Hotel Astor, April 12-13. The presiding officers were Messrs. J. H. Schwacke, president, F. C. Caldwell, vice-president, and Robert Wuest, commissioner. Nearly two hundred and forty members and visitors were registered in attendance. The meeting was notable for the interest and enthusiasm expressed for industrial education, workmen's insurance, accident compensation on an equitable basis, and labor efficiency betterment generally. Though the program lacked, perhaps, some of the novelty characterizing that of last year, it nevertheless included papers and discussions of much value. A commendable feature of the papers and discussions on the relations of labor and capital was the absence of a bullying militant spirit. Although the policy of resistance to unwarranted aggressions and interferences with the rights of employers is upheld as strongly as ever, conciliation and cooperation are being recognized as more and more important factors in smoothing out industrial difficulties. The program included the following reports and papers:

"Industrial Education," F. A. Geier, chairman;
"Apprenticeship," E. P. Bullard, Jr., chairman;
"The Employer and Prevention of Accidents," by John Calder;
"Labor Efficiency Betterment," by H. F. J. Porter;
"Mutuality," by W. A. Grieves;
"Employers' Liability Insurance," Wm. Butterworth, Jr.;
"German Thoroughness," by H. L. Gantt;
"Impressions Regarding Foreign Shop Methods," by Oberlin Smith;
"The St. Louis Method of Technical Education," by Lewis Gustafson;
"Sanitary, Safe and Comfortable Working Conditions," by George Brown.

The following officers were elected:

President, F. C. Caldwell, of the H. W. Caldwell & Son Co., Chicago, Ill.;

First Vice-President, Henry D. Sharpe, of the Brown & Sharpe Mfg. Co., Providence, R. I.;

Second Vice-President, W. A. Layman, of the Wagner Electric Mfg. Co., St. Louis, Mo.;

Treasurer, Howard P. Eells, of the Bucyrus Co., South Milwaukee, Wis.

* * *

NEW STORE OF PETER A. FRASSE & CO.

Peter A. Frasse & Co. have moved into their new store and warehouse at 417-421 Canal St., corner of Sullivan St., New York, where the main office, steel and steel tube departments, and wholesale and retail machinery and metal supply departments are now located. This firm, which was established in 1816, is one of the oldest supply houses in the city, and its move further north from the Fulton St. district, where many of the machinery supply houses have been located for years, is significant of the up town trend of mercantile business generally. The move takes the company into an excellent location in the heart of the steel district, Canal St. being one of the few through cross town streets in the lower part of the city.

The new structure, named the "Brion Bldg." by the directors as a mark of appreciation for the services rendered by the president, Mr. A. E. Brion, has eight stories and a basement. The frontage is 65 feet on Canal St. and 100 feet on Sullivan St. The front of the main floor is the retail supply department and the rear, the wareroom for Shelby steel tubing. The tubing is stored in compartments on sheet metal shelving, the shelving having an advantage over racks in that both long and short lengths can be stacked on it with efficient utilization of space. A 3000-pound capacity traveling crane serves the tube wareroom, transporting material from a side entrance at which trucks are unloaded, clear through to the front, if required.

The executive offices are at the front of the second floor and the wholesale supply department at the rear. The offices of the department managers are on the mezzanine floor, the retail supply manager's office being at the front where the retail floor can be seen.

The basement is the storeroom for Poldi tool steels. Ten racks are provided in which there are 1000 vertical bins for storing the bars on end. The bins are formed with long screw studs projecting from horizontal channels about five feet above the floor. A steel rib is laid in the floor to keep the bars in place. An overhead track and trolley serves the basement floor, connecting with the three elevators. The street elevator is of ample capacity to carry steel stock lying flat. An inclined chute from the street level is provided for handling cases.

The building is fireproof throughout and has been planned for efficiently carrying on the business—so efficiently, in fact, that the management expects to do a larger business than heretofore with no increase of employes.

* * *

MACHINERY SALESMEN

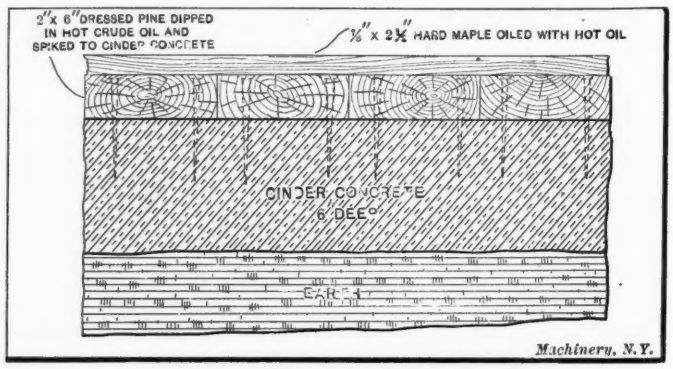
A well-known machinery sales manager and a machine tool expert declares that successful machine salesmen must be caught young and trained exclusively for selling machines. "A salesman who can sell iron, steel, brass tacks or any staple line is no good for machine tool selling, nor can he be trained to it in most cases."

The reason is that the buyers of machine tools are critical men who select tool equipment not as a commodity, but as one selects a piano, a house or a carpet—with a lively sense of the fitness of the article to individual needs. The machine tool buyer is the "man from Missouri"—who must be shown how the machines are built and how used. The seller must combine the intelligence and skill of the designer, the mechanic and the salesman. "Guff" and "hot air" do not sell machines to intelligent customers, and the most desirable customers are those who insist on knowing what they get and on getting what they bargain for.

* * *

BAKER BROS. MACHINE SHOP FLOOR

The machine shop floor of Baker Bros., Toledo, Ohio, was recently rebuilt, the construction being as indicated in the accompanying illustration, showing a cross-section. Six inches of cinder concrete was thoroughly tamped, and allowed to stand for a week. The concrete was then mopped with hot tar, and while the tar was hot 2-inch by 6-inch dressed pine planks, which had been dipped in hot crude oil,


2"x 6" DRESSED PINE DIPPED IN HOT CRUDE OIL AND SPIKED TO CINDER CONCRETE
⅞" x 2½" HARD MAPLE OILED WITH HOT OIL
CINDER CONCRETE 6 DEEP
EARTH
Machinery, N.Y.

Cross-section of Baker Bros. Machine Shop Floor

were spiked to the concrete. On top of the planks hard maple flooring, ⅞ inch by 2½ inches, was laid. This was thoroughly oiled with hot oil after laying.

The hot tar on top of the concrete makes it thoroughly waterproof, thus protecting the pine planking from dampness. No trouble whatever was experienced in driving spikes into the concrete. The construction should prove very durable and generally satisfactory.

* * *

PERSONALS

Robert S. Alter, secretary of the American Tool Works Co., Cincinnati, Ohio, sailed from New York for Europe, March 25, on a pleasure trip.

E. A. Moore, formerly with the Bullard Machine Tool Co., has taken the position of traveling salesman with the Fellows Gear Shaper Co., 25 Pearl St., Springfield, Vt.

Herman Gill has resigned his position with the Fiberloid Co., Springfield, Mass., to take charge of the cost department of the Hendey Machine Co., Torrington, Conn.

E. Thielicke of C. Thielicke, Berlin, Germany, is visiting the United States to secure selling rights for American machine tools. His address is Bullard Machine Tool Co., Bridgeport, Conn.

Lewis R. Gilbert, formerly engineer with Charles Schmidt of the Peerless Motor Car Co., Cleveland, Ohio, announces that he is no longer connected with the company in any capacity.

Frank J. McCarty, Springfield, Mass., has resigned as draftsman for the Gilbert & Barker Mfg. Co. to take charge of the designing and construction work of the Tate & Jones Co., Pittsburg, Pa.

C. H. Pearson, formerly with the Noera Mfg. Co., Waterbury, Conn., has taken a position with the hoist department of the Yale & Towne Mfg. Co. Mr. Pearson's field of operations will be in the West.

David E. Jackman of E. S. Jackman & Co., Chicago, Cleveland and Pittsburg, has withdrawn to become treasurer of the Firth-Sterling Steel Co., McKeesport, Pa. Mr. Jackman assumed his new responsibilities April 1.

J. Frank Duryea, vice-president, and William M. Remington, mechanical engineer, of the Stevens-Duryea Co., Chicopee Falls, Mass., are making a six weeks' trip through Italy, France and Scotland in the interests of their company.

Rodman Gilder, secretary of the Crocker-Wheeler Co., manufacturer of electrical machinery, Ampere, N. J., has resigned to become associated with the brokerage house of Dick Bros. & Co., New York. Mr. Gilder was with the Crocker-Wheeler Co. seven years.

F. Charles Scribner, for the past three and a half years general foreman of the gage and tool departments of the Wells Bros. Co., Greenfield, Mass., has resigned to become inspector of gages with the Colt's Patent Firearms Mfg. Co., Hartford, Conn.

Erik Oberg, associate editor of MACHINERY, will sail for Europe May 6, on a two months' trip through England, Holland, Belgium, Germany and Sweden. Mr. Oberg expects to attend the graduation exercises of his alma mater, the Government Technical College at Boras, Sweden. He will observe industrial conditions, especially in Belgium and Sweden.

John R. Ide has resigned his position in the sales department of the Hyatt Roller Bearing Co. and has engaged with the New Departure Mfg. Co., Bristol, Conn., maker of New Departure ball bearings. Mr. Ide will continue to reside in Detroit and will be connected with the western branch of the New Departure Mfg. Co. which is shortly to be opened in that city.

Henry Morris, manager and treasurer of the Western Tool & Mfg. Co., Springfield, Ohio, sailed for Europe April 8, on the *Frederick der Grosse*. Mr. Morris will visit the Turin Exposition, where the company has an exhibition, and several countries of Europe, returning through England. While abroad, Mr. Morris expects to close contracts with some of the large European dealers.

E. Ronceray has been elected vice-president of the Committee of Admission and Installation, Group IV., Classes 23 to 27, of the Turin Exposition, Italy, which includes various machine tools, heating processes and forging tools, machine tools and small tools, machines for various work, and machines for building materials. Mr. Ronceray is a partner of the firm of Ph. Bonvillain & E. Ronceray, Paris, France.

Dr. Robert Bosch of Stuttgart, Germany, designer and inventor of the Bosch magneto and other Bosch products, is on a business trip in the United States. Dr. Bosch is much interested in our manufacturing industries, and with Mr. Otto Heins, president of the Bosch Magneto Co., New York, is making an extended tour of the country with the object of visiting some of the larger industries as well as the natural points of interest.

A. H. Tuechter, president of the Cincinnati Bickford Tool Co., Cincinnati, Ohio, sails for Europe on May 17, on the *President Lincoln* of the Hamburg-American Line, for a four months' trip through Europe, combining business with pleasure. The combination of the Cincinnati and Bickford plants, and the labor of moving them both into their large new works at Oakley have kept Mr. Tuechter close to business for a long time, and he is entitled to more rest than he will probably get on this trip, if there is any chance to talk machine tools.

* * *

OBITUARIES

Lieut-Col. Frank E. Hobbs, commandant of the Rock Island Arsenal, Rock Island, Ill., died at the Army and Navy Hospital, Hot Springs, Ark., April 11, aged fifty-six years.

Alonzo H. Johnson, who for over forty years worked as an armorer at the United States Armory, Springfield, Mass., died at his home in that city March 30, aged eighty-three years.

Chas. E. Mitchell, president of the Stanley Rule & Level Co., New Britain, Conn., died at his home March 17, aged seventy-three years. Mr. Mitchell was Commissioner of Patents under President Harrison.

Charles W. Hunt

Charles G. Thaxter, master mechanic of the Dennison Mfg. Co., South Framingham, Mass., died from Bright's disease at Orlando, Florida, March 31. Mr. Thaxter had been in the employ of the Dennison Mfg. Co., for forty years, entering the service of the concern when a boy and rising to the position of master mechanic. He worked with Mr. Dennison for years perfecting the company's machines, and had recently, alone, done much to forward the interests of the company.

George A. Barnes, secretary of the Whitman & Barnes Mfg. Co., Akron, Ohio, died at Akron, March 22, in his fifty-fourth year. Mr. Barnes was born in Cincinnati, Ohio. He began his long service with the Whitman & Barnes Mfg. Co. at the company's Syracuse factory in 1876. In 1879 he was transferred to the Canton, Ohio, works of the company, remaining there as manager until 1895, when he removed to Akron, where he resided until his death, with the exception of the years 1902 and 1904, during which time he was located at the company's offices in Chicago. At the time of his death Mr. Barnes was secretary of the company, and a director and member of the executive board. He is survived by a widow and one son, H. L. Barnes, who is superintendent of the Whitman & Barnes Mfg. Co.'s Chicago works.

CHARLES W. HUNT

Charles W. Hunt, president of the C. W. Hunt Co., West New Brighton, Staten Island, N. Y., died suddenly at his home, Grymes Hill, Staten Island, March 27, aged seventy years. He had been suffering from asthma for several months, but had been able to attend to business up to two weeks prior to his death. Mr. Hunt established a retail coal business at West New Brighton in the late '60s. Observing the need of an economical and expeditious method of unloading coal barges and carrying coal, he invented a conveyor system and installed it in his yard. The success of the system brought orders from other coal yards for similar apparatus, and this was the beginning of the manufacture of coal-carrying machinery at West New Brighton. The business became one of the largest in that line in the United States, and is to-day one of Staten Island's largest and most prosperous manufacturing enterprises. The handling and conveying machinery produced is in use in almost all parts of the world. During his lifetime Mr. Hunt took out one hundred and forty-seven patents, largely on machinery for handling materials, but including many other devices also. Mr. Hunt was a prominent figure in mechanical engineering circles, and a member of many clubs and societies. He was a life member of the American Society of Mechanical Engineers; vice-president of the society in 1892-94, and president 1897-98.

WILLIAM S. GORTON

William S. Gorton, secretary and general manager of the Standard Welding Co., of Cleveland, Ohio, was killed at the railroad crossing close to his factory on April 17. Mr. Gorton with his chauffeur was just returning from a ride, when the car was struck by the locomotive of a passenger train on the Lake Shore road, and his body was thrown almost against the fence of his own factory, both he and the chauffeur being instantly killed.

Mr. Gorton was born in Waterford, Conn., February 12, 1859, and educated in the common schools of New London, Conn. He was for four years with the Marine Department of the United States Coast Survey, and had considerable experience

William S. Gorton

as an engineer on cable road construction in Eastern cities. Later he became connected with the Standard Tool Co. of Cleveland in mechanical and executive capacities, and in 1899 he organized the Standard Welding Co., which for some time occupied a small plant in the rear of the Standard Tool Co.'s present buildings. Mr. Gorton was a man of tremendous energy and of high executive ability, and the welding business expanded under his management until it became necessary to build the present extensive plant which it occupies at the junction of West 76th St. and L. S. & M. S. R. R. in Cleveland. Mr. Gorton leaves a widow and four children.

* * *

COMING EVENTS

May 9-10.—Annual meeting of the American Association of Refrigeration, La Salle Hotel, Chicago, Ill. J. F. Nickerson, secretary, Chicago.

May 15-17.—Sixteenth annual convention of the National Association of Manufacturers at the Waldorf-Astoria Hotel, New York. John Kirby, Jr., president; J. Philip Bird, general manager; and George S. Boudinot, secretary, 30 Church St., New York.

May 18-19.—Spring convention of the National Machine Tool Builders' Association at Atlantic City, N. J. Marlborough-Blenheim Hotel, headquarters. Charles L. Hildreth, secretary, Worcester, Mass.

May 18-19.—Semi-annual meeting of the Ohio Society of Mechanical, Electrical and Steam Engineers, Youngstown, Ohio. Prof. Frank E. Sanborn, Columbus, Ohio, secretary-treasurer.

May 30-June 2.—Spring meeting of the American Society of Mechanical Engineers at Pittsburg, Pa., headquarters, Hotel Schenley. Local committee, E. M. Herr, chairman; Elmer K. Niles, secretary; office of local committee, 2511 Oliver Bldg., Pittsburg. The professional sessions will be held in the lecture hall of the Carnegie Institute, near the headquarters, Wednesday morning and evening, and Thursday and Friday morning. A number of inspection trips to various industrial plants in the vicinity have been planned. Calvin W. Rice, secretary, 29 West 39th St., New York.

June 14-16.—Annual convention of the American Railway Master Mechanics' Association, Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Bldg., Chicago.

June 14-21.—Annual convention of the Railway Supply Manufacturers' Association, in conjunction with the American Railway Master Mechanics' and Master Car Builders' Association, Atlantic City, N. J. J. D. Conway, secretary, 2135 Oliver Bldg., Pittsburg, Pa.

June 15-17.—Mid-summer meeting of the Society of Automobile Engineers at Dayton, Ohio. Coker F. Clarkson, general manager, 1451 Broadway, New York.

June 19-21.—Annual convention of the Master Car Builders' Association, Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Bldg., Chicago.

June 20-23.—National Gas and Gasoline Engine Trades Association convention, Hotel Pontchartrain, Detroit, Mich. Albert Stritmatter, secretary, Cincinnati, Ohio.

NEW BOOKS AND PAMPHLETS

ELECTRICITY IN THE DEVELOPMENT OF THE SOUTH. By George Westinghouse. 19 pages, 6 by 9 inches.

An address given before the Southern Commercial Congress at Atlanta, Ga., March 10, 1911.

PRACTICAL SILO CONSTRUCTION. By A. A. Houghton. 69 pages, 5 by 7 inches. Illustrated. Published by Norman W. Henley & Son, 132 Nassau St., New York. Price 50 cents.

This is No. 3 of a series entitled "Concrete Workers' Reference Books," and has to deal with the construction of monolithic and block silos.

RECORD OF TRANSPORTATION LINES OWNED AND OPERATED AND ASSOCIATED WITH THE PENNSYLVANIA RAILROAD, FOR THE YEAR ENDING DECEMBER 31, 1910. 49 pages, 9½ by 12 inches.

Detailed account of the trackage and location of the integral lines of the Pennsylvania System, compiled from data on file in the office of the chief engineer of maintenance.

METAL WORK AND ETCHING. By John D. Adams. 96 pages, 5 by 7 inches. 49 illustrations. Published by the Popular Mechanics Co., Chicago, Ill. Price 25 cents.

This is one of the latest of the Popular Mechanics 25-cent series of industrial handbooks, and is a manual for art metal workers, giving the necessary details for the production of many interesting articles in sheet metal.

MOLDING CONCRETE CHIMNEYS, SLATE AND ROOF TILES. By A. A. Houghton. 61 pages, 5 by 7 inches. Illustrated. Published by Norman W. Henley & Son, 132 Nassau St., New York. Price 50 cents.

No. 4 of the concrete workers' reference series is a practical treatise explanatory of the construction of block and monolithic type of concrete chimneys, monolithic roofs and the molding of concrete slate, tiles and slabs.

MOLDING AND CURING ORNAMENTAL CONCRETE. By A. A. Houghton. 58 pages, 5 by 7 inches. Illustrated. Published by Norman W. Henley & Son, 132 Nassau St., New York. Price 50 cents.

In this book, No. 5 of the series, practical methods covering the various methods of preparing the molds and filling with the concrete mixture are treated, as well as methods of remedying defects in the cast, surface treatment of various effects, and proper proportion and preparation of the concrete.

THE FLOW OF HEAT THROUGH FURNACE WALLS. By Walter T. Ray and Henry Kreisinger. 32 pages, 6 by 9 inches. Published by the Bureau of Mines, Department of the Interior, Washington, D. C., as Bulletin No. 8.

This bulletin contains a statement of the results obtained in a series of tests on the furnace which forms a part of the government fuel-testing plant at Pittsburg, Pa., to determine the heat losses through the walls. Some instructive deductions were drawn from these tests, which should prove of especial interest to power-plant engineers.

THE MECHANIC, 1911. H. W. Sherlock, editor-in-chief. 178 pages, 10 by 8 inches. Illustrated. Published by the senior class of Williamson Free School of Mechanical Trades, Williamson School P. O., Pa.

The board of editors of the seventh volume of "The Mechanic" deserve commendation for the excellent year-book which they have produced this Spring. All the write-ups and the descriptive matter are of a high order, while a good deal of ingenuity is displayed in the character skits, etc., contained in the book. Many original departures from the customary college year-book are embodied, improving the book materially.

INVENTORS AND INVENTIONS. By H. Robinson. 95 pages, 6½ by 10 inches, paper. Illustrated. Published by H. Robinson, 41 West 33d St., New York. Price 25 cents.

The method in which Mr. Robinson treats the subject is unique, the unusual treatment carrying out the object of the author in writing the book, which is to awaken the public conscience to the great injustice continually being done to a numerous and worthy class of intellectual toilers, and the evil to the general public resulting therefrom. A strong feature is made of the comparatively negligible protection that the government affords the poor inventor against infringement by powerful corporations.

MACHINE SHOP MECHANICS. By Fred H. Colvin. 177 pages, 5 by 7 inches. 116 illustrations. Published by the McGraw-Hill Book Co., 239 West 39th St., New York. Price $1.

This book has for its object the explaining of the principles of common things seen daily in shop work; the underlying reasons are explained in common language. The chapters are as follows: Levers; The Screw and Wedge; Inclined Planes; Gravity; Friction; Heat; Inertia; Belts and Pulleys; Block and Tackle; Gearing; Centrifugal Force; Hydraulics; Steam Pressure; The Force of a Blow; Strength of Materials; Shafting; Action and Reaction; Beams; Measuring Moments; and Force Diagrams.

PLUMBING AND HOUSEHOLD SANITATION. By J. Pickering Putnam. 718 pages, 5½ by 8 inches. 649 illustrations. Published by Doubleday, Page & Co., Garden City, N. Y. Price $3.75.

It would take one well versed in the details of sanitary engineering to find the omissions in this large work, the subject seeming to have been exhaustively treated. The volume embodies the results of more than a quarter of a century's study and research in sanitary plumbing from both the theoretical and practical standpoint, and is the immediate outcome of a course of lectures delivered before the plumbing school of the North End Union, Boston. The book is voluminous, containing forty-four chapters, and a mere enumeration of the chapter heads would fill much space. It is a work that should be of interest and value to the layman as well as to the sanitary engineer.

INCREASE THE CROP PER ACRE. Issued by the Pennsylvania Railroad, Philadelphia, Pa. 112 pages, 6 by 9 inches. Illustrated with 36 full-page and 17 part-page engravings.

"Increase the Crop per Acre" is the title of a booklet issued by the Pennsylvania, Railroad, which is to be distributed throughout the territory traversed by its lines. This pamphlet deals with the application of dynamite on the farm, and illustrates with half-tones the blasting of stumps, forming of ditches, road building, plowing, etc., and gives a final chapter on the "Principal of Explosives," which should be of interest to the average reader as well as to the farmer. With this latest addition to its agricultural literature the Pennsylvania Railroad has now on hand, for distribution eleven pamphlets including: "Potato Culture," "Alfalfa," "Use of Lime on Land," "Seed Grain Suggestions," "Orchard Primers—Planting, Pruning, Spraying, and Cultivation," "The Pennsylvania Railroad and the Farmer," and "Good Roads at Low Cost."

CHEMISTRY FOR BEGINNERS; INORGANIC. By Edward Hart. 207 pages, 5¼ by 6¾ inches. 80 illustrations. Published by the Chemical Publishing Co., Easton, Pa. Price $1.

This is No. 1 of a set of three volumes:—"Chemistry for Beginners"—the other two dealing with organic chemistry and experiments. That this book has met with appreciation is evidenced by its appearance in the fifth edition since the first publication in 1896. The strong feature of the book is its simplicity and practicability; the author realized that but a few of those who study chemistry ever become professional chemists, and hence the common subjects of everyday life are those whose chemical aspects are enlarged upon. The aim was to make the book utilitarian; anyone who has studied complete works on the subject will realize that this is a simple treatment. An objectionable feature in our estimation of the work is the "new spelling" which so changes many of the older chemical terms that in several instances the average reader does not immediately realize what is meant.

PRINCIPLES OF MACHINE WORK. By Robert H. Smith. 388 pages. 5 by 8 inches. 434 illustrations. Published by the Industrial Education Book Co., Boston, Mass. Price $3.

With the companion book, "Elements of Machine Work," by the same author, a thorough treatment of the elements and principles of machine work is presented in a style adapted to the needs of students in technical, manual training and trade schools, and apprentices in the shop. These books represent a great deal of painstaking work on the part of the author, and his endeavors should be crowned with success, for they meet the requirements of the class noted thoroughly, being expressed in a clear, intelligible manner. The subjects treated are too numerous to enumerate, but the main features dealt with are engine and speed lathes, drilling and grinding machines, carbon and high-speed steel cutting tools, measuring, turning, fitting, threading, chucking, drilling, reaming, jigs, fixtures and cylindrical grinding. The illustrations, for the most part in line perspective, make the description clear and useful, especially to the beginner in the mechanical field.

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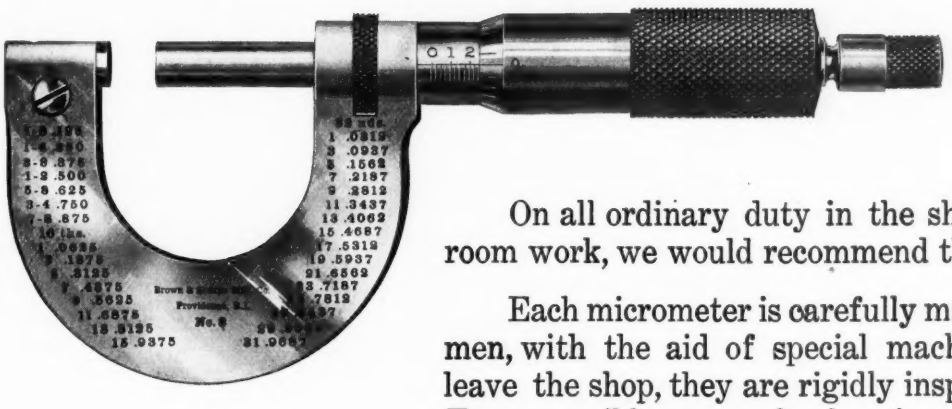

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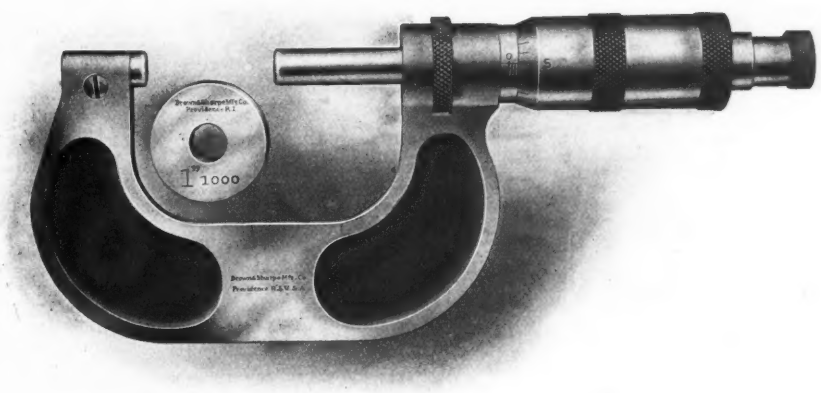

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THE STRENGTH OF OXY-ACETYLENE WELDS IN STEEL. By Herbert L. Whittemore. 65 pages, 6 by 9 inches. Illustrated. Published by the University of Illinois, Urbana, Ill., as Bulletin No. 45.

This bulletin describes a somewhat extensive investigation of the strength of oxy-acetylene welded joints in thin steel plates, and of the effect of regulating the flame and of various methods of manipulation on the strength of the weld. The strength of welded joints made by this process obtained from the results of an extensive series of tests is recorded. A considerable amount of information as to the convenience and efficiency of various methods of manipulating the oxy-acetylene blowpipe flame is given, and it is shown that with careful manipulation a welded joint between thin steel plates may be expected to have a strength of about 85 per cent of that of the solid steel plates. A study of the proper proportioning of the gases and of the regulation of the flame was made, and it was found that the proper regulation of the flame is not a matter of great difficulty. The limitations and adaptability of the process are discussed, and it is shown to be particularly well adapted to the welding of thin plates and machine parts.

LOCOMOTIVE BREAKDOWNS. By Geo. L. Fowler, revised and enlarged by Wm. W. Wood. 293 pages, 4½ by 6½ inches. 98 illustrations. Published by Norman W. Henley & Son, 132 Nassau St., New York. Price $1.

Since its original publication, this book has been revised a number of times, so that the 1911 production is the seventh revised and enlarged edition through which it has passed. The prime object of the work is to instruct engineers how to avoid delay in case of accidents, and what should be done when breakdowns occur. While most of the material contained has been largely gleaned from articles published in the technical press many years ago, the constant revisions have kept it up-to-date, the chapter on Walschaerts valve gear troubles being an evidence of this. The chapters are: Defective Valves; Accidents to the Valve Motion; Accidents to Cylinders, Steam Chests and Pistons; Accidents to Guides, Crossheads and Rods; Accidents to Valve Motion, Walschaerts Radial Gear, Baker-Pilloid Improved Valve Gear; Accidents to Running Gear; Truck and Frame Accidents; Boiler Troubles; Defective Throttle and Steam Connections; Defective Draft Appliances; Injector Troubles; Accidents to Cab Fixtures; Tender Accidents; Miscellaneous Accidents; Accidents to Compound Locomotives; Tools and Appliances for Making Engine Repairs; Locating and Remedying Air-Brake Troubles; The Pyle National Electric Headlight; Rules, Tables and other Information.

ELEMENTS OF MACHINE WORK. By Robert H. Smith. 192 pages, 5 by 8 inches. 204 illustrations. Published by the Industrial Education Book Co., Boston, Mass. Price $2.

At the present time when many so-called "practical" books are making their appearance, it is seldom that one is published which is as thoroughly practical as this one, which is a companion book to "Principles of Machine Work," by the same author. The amount of labor involved in the preparation must have been great, for the work treats of nearly all the essential features of shop work in a thoroughly practical manner, illustrating the descriptions clearly with a large number of engravings. In the contents, the following subjects are treated: History and Origin of Machine Tools; Equipment for Teaching and Manufacturing; Materials Used for Machine Construction; Reading Drawings; Standards of Linear Measurement; Measuring, Laying Out and Operating Tools, and Methods of Use; Hand and Power Chipping; Tool Grinding; Files; Hand and Machine Filing; File Manufacture; Scrapers, Scraping and Standard Surface-plates; Polishing, Annealing, Hardening and Tempering Carbon Steel; High-speed Steel; Casehardening; Straightening Hardened and Tempered Tools; Testing Hardness with the Scleroscope; Cutting off Stock by Hand and Machine Methods; Pipe and Pipe Fittings; Pipe Tools; Hand and Machine Methods of Piping; Straightening and Bending; Peening and Riveting; Hand Drilling; Soldering; Brazing; Babbitting; Power Transmission; Aligning and Leveling Shafting, and Installing Machines; and Table and Other Data Used in Machine Work.

THE TEMPERATURE-ENTROPY DIAGRAM. By Chas. W. Berry. 393 pages, 5 by 7½ inches. 125 illustrations. Published by John Wiley & Sons, 43 E. 19th St., New York. Price $2.50.

That this book seems to have been received well is evidenced by the fact that it is now passing into the third revised edition since its original appearance in 1905. Minor insertions have been made in this last edition in the chapters on the flow of fluids, gas engine cycles, and the non-conducting steam engine. The chapter on refrigeration and the warming engine has been expanded into separate chapters on each subject, and other minor changes are also incorporated. The book is not intended for the advanced student, nor is it designed for the use of anyone entirely ignorant of thermodynamics, as the reader is assumed to have an elementary knowledge of the fundamental theory and equations. Chapters are as follows: General Discussion, Reversible Processes and Cycles, Effect of Irreversibility; The Temperature-Entropy Diagram for Perfect Gases; for Saturated Steam; for Superheated Vapors; for the Flow of Fluids; Mollier's Total Energy-Entropy Diagram; Thermodynamics of Mixtures of Gases, of Gases and Vapors, and of Vapors; The Temperature-Entropy Diagram Applied to Hot-Air Engines; Applied to Gas-engine Cycles; The Gas-engine Indicator Card; The Temperature-Entropy Diagram Applied to the Non-conducting Steam Engine; The Multiple-fluid or Waste-heat Engine; The Temperature-Entropy Diagram of the Actual Steam-engine Cycle; Steam-engine Cylinder Efficiency; Liquefaction of Vapors and Gases; Application of the Temperature-Entropy Diagram to Air Compressors and Air Motors; Discussion of Refrigerating Processes; Discussion of Kelvin's Warming Engine; Entropy Analysis in the Boiler-Room.

CATALOGUES AND CIRCULARS

RICHARD W. JEFFERIS, Camden, N. J. Folder describing the Jefferis pressed steel lockers.

MCNAB & HARLIN MFG. CO., New York. Booklet describing standard iron body straight-way gate valves.

VICTOR APPLIANCE CO., Watervliet, N. Y. Small catalogue of automobile and motor boat specialties.

S. W. CARD MFG. CO., Mansfield, Mass. Catalogue No. 26, of taps, dies and screw plates, in small, compact form for ready reference.

RICHARD J. FLINN, West Roxbury, Mass., has issued a small pamphlet describing the Flinn differential steam trap, showing a typical installation.

SPRAGUE ELECTRIC CO., 527 West 34th St., New York. The company has just produced its 1911 fan catalogue, No. 323, which is an attractive piece of printing.

BADGER STATE MACHINE CO., Janesville, Wis. Catalogue of punches, shears, bending rolls, and wood-working machinery, illustrated and containing brief descriptions.

C. E. SARGENT, Chicago, Ill., has just published a 16-page catalogue of his various steam and gas engine specialties, illustrating and briefly describing them. Some interesting devices are shown.

MILWAUKEE LOCOMOTIVE MFG. CO., Milwaukee, Wis., describes its gas-driven mining-type locomotives in bulletin No. 101. The different types manufactured are illustrated.

CROCKER-WHEELER CO., Ampere, N. J. Bulletin No. 130, superseding bulletin No. 109, describes its small direct-current generating sets, direct-connected to Giles type E engines.

BUFFALO FORGE CO., Buffalo, N. Y. Circular on spray nozzles and strainers for chemical plants, blast furnaces, mine moistening, gas washing, condenser systems, paper mills, etc.

BRISTOL CO., Waterbury, Conn. Bulletin No. 131 is a 44-page illustrated catalogue of Bristol's recording voltmeters for switchboard and portable service, with 6-, 8- and 12-inch charts.

WESTON ELECTRICAL INSTRUMENT CO., Waverly Park, N. J., has just published a folder illustrating a line of Weston A. C. switchboard indicating instruments with brief descriptions.

ROCKWELL FURNACE CO., 26 Cortlandt St., New York. Bulletin No. 28, describing the "Simplex" melting furnace, which is adapted for both oil, gas or fuel. The construction and operation are described.

AMERICAN OXHYDRIC CO., Milwaukee, Wis., in its latest catalogue shows some remarkable examples of cutting and welding metals by the "oxhydric" process. The system is described and illustrated in its various applications.

BILLINGS & SPENCER CO., Hartford, Conn., has published a booklet entitled "Specialties" which describes the minor inventions made by Mr. C. E. Billings. These include magazine screwdrivers, sportsmen's knives, key-rings, tack hammers, snap hooks, etc.

W. A. PECK, 141-145 Brewery St., New Haven, Conn. Circular of the "Sure" center finder, a simple device for locating the center of revolving work and drilling and countersinking the center, all three operations being performed without change of tool.

AMERICAN ASPHALTUM & RUBBER CO., 600 Harvester Bldg., Chicago, Ill., has issued a catalogue devoted to furthering asphalt mastic floors. The advantages of this type of floor over a wood and concrete floor are dealt with, and many other advantages enumerated.

INGERSOLL MILLING MACHINE CO., Rockford, Ill. Circular of heavy-duty knee-type milling machines, having horizontal and vertical spindles which may be used independently or in unison. The circular gives the general specifications for the Nos. 3 and 5 machines.

SOUTH BEND MACHINE TOOL CO., South Bend, Ind. Price list and catalogue No. 41 describes the foot and power screw-cutting engine lathes made by this concern. The important details of construction are illustrated and described as are also the various attachments adapted to these lathes.

CARBORUNDUM CO., Niagara Falls, N. Y. Revised American Statesmen Series, Vol. III, "Captain John Smith," by F. W. Haskell, president of the company. This is one of a series of humorous biographies of prominent statesmen published from time to time by the Carborundum Co., to interest and amuse its customers.

GUARANTEE CONSTRUCTION CO., 140 Cedar St., New York. This company has just issued a catalogue describing equipment for the handling and storage of coal and ashes in power plants. For the most part the book is devoted to descriptions of actual installations made by the company, illustrated by line drawings and half-tones.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4799, "Water-wheel-driven Alternators"; No. 4806, "Electric Fans"; No. 4816, "Running Light Telltale Boards" (superseding No. 4322); No. 4820, "Curve Drawing Ammeters and Voltmeters" (superseding No. 4706); B-3038, "Electricity on the Farm"; B-3075, "Charging the Electric."

FIRTH-STERLING STEEL CO., E. S. JACKMAN & CO., agents, Chicago, Ill., has issued an imitation blueprint sheet entitled "Firth-Sterlingism," being a sort of eulogy on the human element involved in the manufacturing of steel and tools. Some interesting deductions are drawn in an unusual manner; the underlying feature of it all is the promotion of Firth-Sterling steel.

PETER A. FRASSE & CO., 417-421 Canal St., New York. Wall hanger map of Manhattan and a portion of the Bronx and Brooklyn with references at the side listing various depots, ferries, steamboat and steamship companies, hotels and places of amusement. This map will be found of much interest and value to those visiting New York or doing business there; it will be sent free on request.

BRUCE-MACBETH ENGINE CO., Cleveland, O. In this catalogue are described the latest types of Bruce-Macbeth vertical multi-cylinder gas engines for electric lighting, pumping and all general power purposes, using either artificial, natural, or producer gas, or gasoline. This company is carrying on the combined interest of the Bruce-Meriam-Abbott Co., and The Macbeth Iron Co., which firms were consolidated about two years ago.

SPRINGFIELD MACHINE TOOL CO., 631 Southern Ave., Springfield, Ohio. Illustrated catalogue G recently produced by this company is a very complete and thorough catalogue of lathes. The component parts of the different lathes manufactured by this company are described and illustrated in detail. The complete line of lathes is also listed, as well as several of the shapers manufactured by the company. Auxiliary machinery in the form of straightening presses is also included.

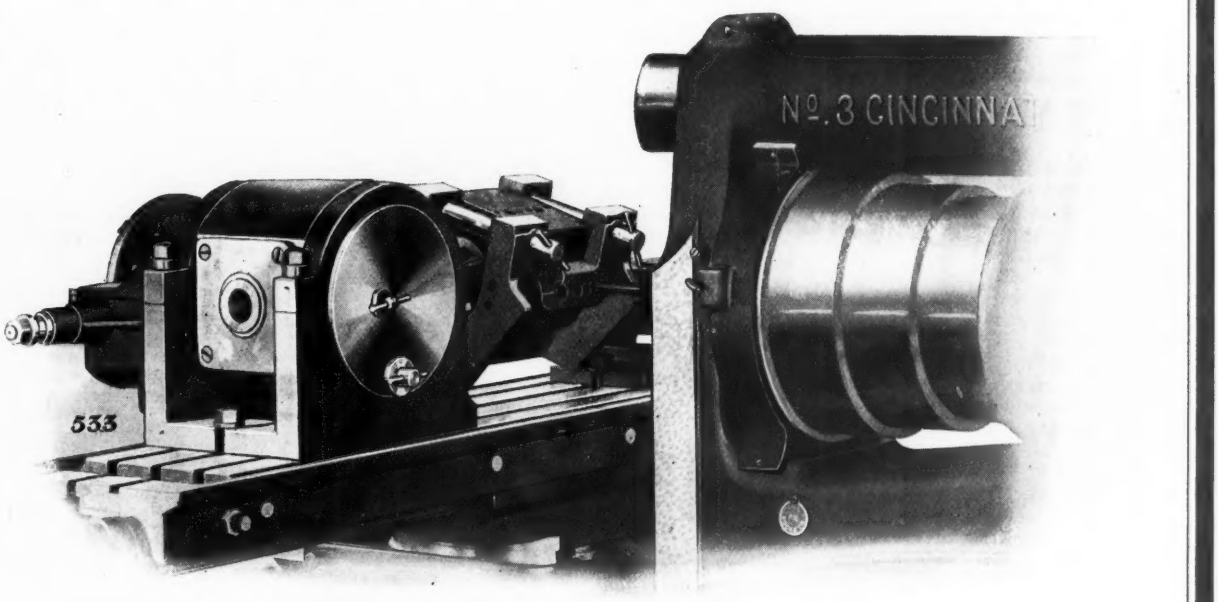
J. S. BRETZ CO., importer, 1004 Times Bldg., New York. Catalogue describing the product of Fichtel & Sachs, Schweinfurt a. M., Germany. The first part contains a series of views illustrating the manufacture of ball bearings by this German firm. The main feature of the catalogue is the list of the different types of ball bearings with numerous illustrations consisting for the most part of lettered drawings and tables. These and other data make the catalogue valuable for the designing engineer, etc.

INTERNATIONAL ENGINEERING CO., 1779 Broadway, New York. Catalogue of R. B. F. ball bearings, containing data on capacity of ball bearings, forms of mounting, etc. The various sizes of radial bearings are tabulated, the tables listing the sizes in millimeters and inches, number of balls and size of balls; also carrying capacities, weight and price. Thrust bearings with spherical self-aligning seats are listed for light and heavy service and examples of practice are illustrated. The company also supplies limit gages of the plug and snap type for testing outer and inner ball bearing races.

RIVETT LATHE MFG. CO., Brighton P. O., Boston, Mass. Catalogue No. 27 on Rivett precision tools, precision lathes, milling machines, grinders and attachments for same. The machines illustrated and described are as follows: Rivett grinders, Nos. 3, 4, 5 and 6 with details of construction; bench miller with attachments; bench lathes, Nos. 3, 3½, 4 and 5 with attachments and equipment for all classes of precision work, including cutter milling, gear cutting attachments, etc. The catalogue is a handsome production illustrated with many fine halftones and it will be found of much interest to machine shop proprietors, toolmakers and mechanics generally.

NICHOLSON FILE CO., Providence, R. I. Catalogue of files and rasps, profusely illustrated with half-tone engravings of the factories at Providence, R. I., Port Hope, Ont., Anderson, Ind., and Paterson, N. J.; files, rasps, sections of files showing comparative cuts, toolmakers' files, manicure files, scrapers, rifflers, handles, file cleaners, etc. All the illustrations of files are full size, and in case of large rasps the illustrations extend across two pages, making a fine

CINCINNATI UNIVERSAL TOOL ROOM MILLERS



Making ordinary drill jigs is an every-day tool room job, but this one is unusual. It has 12 holes distributed over all its sides—some of them radial, others at angles.

By holding it between centers the spacing and angles are obtained by a combination of movements; circumferentially by indexing; at an angle with the radius by indexing and vertical adjustment; and lengthwise by means of the lead screw.

The lengthwise and vertical measurements are checked by micrometer calipers in the usual way. They show an accuracy within ½-thousandth inch (.0005″), but the accuracy of the circumferential spacing results entirely from the accuracy of the index, and comes within 1-10th of a degree, or 6-10ths of a thousandth (.0006″), on this diameter of 7″.

Cincinnati Millers are as famous for their accuracy as for their productive capacity

Ask for the catalogue.

The Cincinnati Milling Machine Company

CINCINNATI, OHIO, U. S. A.

EUROPEAN AGENTS—Alfred H. Schutte, Cologne, Brussels, Milan, Paris and Barcelona. Donauwerk Ernst Krause & Co., Vienna, Budapest, Prague and Berlin. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow.
CANADIAN AGENT—H. W. Petrie, Limited, Toronto, Montreal and Vancouver. AUSTRALIAN AGENTS—Thos. McPherson & Son, Melbourne.
JAPAN AGENTS—Andrews & George, Yokohama. CUBAN AGENT—Adolfo B. Horn, Havana.
ARGENTINE AGENTS—Adolfo Mantels & Co., Buenos Ayres.

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effect. The catalogue, which is one of the handsomest devoted to a metal product that we have seen, will be found interesting and indispensable by file users, and of educational value to those who are uncertain as to the correct names of files.

TRADE NOTES

HYATT ROLLER BEARING CO., Newark, N. J., has appointed Mr. Alex Crawford purchasing agent. Mr. Crawford assumed his duties April 17.

CROCKER-WHEELER CO., Ampere, N. J., announces the appointment of Mr. Clarence E. Delafield, in place of Mr. R. N. C. Barnes, resigned, as district manager for the Boston office.

L. S. STARRETT CO., Athol, Mass., will build an addition to its factory consisting of three brick buildings, *viz.*: 40 by 123 feet, three stories; 39 by 50 feet, three stories; and 40 by 50 feet, one story.

NEW DEPARTURE MFG. CO., Bristol, Conn., maker of New Departure ball bearings, is enlarging its already large corps of engineers. Victor E. Page, of Pawtucket, R. I., for some years past managing editor of the *Automobile Journal*, is the latest recruit to the engineering force.

PETER A. FRASSE & CO., New York, have moved their main office, steel and steel tubing department, wholesale and retail supply departments to their new fireproof building, 417-421 Canal St., corner Sullivan St., which is equipped with every facility for expeditiously handling material.

BUFFALO FORGE CO., Buffalo, N. Y., which held the contract for the installation of the ventilating system in the Anchor Line steamer *Tionesta* previous to the 1910 season, has recently been awarded contracts for similar installations on the boats, *Juniata* and *Octarara* of the same company.

FIRTH-STERLING STEEL CO., E. S. JACKMAN & CO., agents, Chicago, Ill., announces that David E. Jackman, of the firm of E. S. Jackman & Co., has withdrawn to take the position of treasurer of the Firth-Sterling Steel Co., McKeesport, Pa. Mr. Jackman assumed his new responsibilities April 1.

WILLIAM GARDAM & SON, New York, announces that it has moved from 221 Fulton St. to 80-86 Park Place, New York. The new quarters are commodious and provide facilities for doing a much larger business in New York than was heretofore possible. The factory at Arlington, N. J., remains as before.

DRESES MACHINE TOOL CO., Cincinnati, Ohio, finds business conditions in its line of machines fairly good. The company has a considerable foreign business, and has recently made large shipments to Mexico. Its Mexican agent reports that the disturbances in Mexico are of a local nature, and do not interfere with the regular trade relations.

BUFFALO STEAM PUMP CO., Buffalo, N. Y., recently secured an order from the Borough of South River, N. J., for its new water works plant. The pumping equipment consists of two 5-inch two-stage centrifugal pumps, each having a capacity of 800,000 gallons per day against a total head of 135 pounds. The pumps will be driven by 75 H. P., 1700 R. P. M. Fort Wayne motors.

ROYERSFORD FOUNDRY & MACHINE CO. of Royersford and Philadelphia, Pa., has engaged double space this year to accommodate a comprehensive exhibit of Sells roller bearings, "Rollerine," and punching and shearing machines at the Master Mechanics' and Master Car Builders' conventions at Atlantic City, N. J., in June. Mr. John D. Sells, manager, will be in charge of the exhibition.

SAURER MOTOR CO., 30 Church St., New York, has recently been organized to operate the American rights to make the Saurer truck, the well-known Swiss make. The new company has been incorporated under the laws of New Jersey and capitalized at $1,600,000. C. Philip Coleman is president; Frank S. Richards, treasurer; and Vernon Monroe, secretary. The manufacture of 3-, 5- and 7-ton Saurer trucks will be entered upon immediately in the plant at Plainfield, N. J.

BANTAM ANTI-FRICTION CO., Bantam, Conn., has purchased the property known as the "Bantam Inn" next to it and will continue the hotel under the name of the "Anti-Friction Inn," and will utilize the adjoining land for the erection of additional factory buildings. The company's ball bearing business was touched very lightly during the past few months of "business frost." The factory organization has run along on the regular schedule of nine hours per day without having to work on stock product.

STANDARD GAUGE STEEL CO., Beaver Falls, Pa., has opened branch offices in Chicago, Ill., and Philadelphia, Pa. The Chicago office is at No. 540 Old Colony Bldg., in charge of Mr. Gillen. The Philadelphia office is No. 516 Pennsylvania Bldg., in charge of Mr. W. L. Mellon. The company's finished steel specialties include crankshafts, connecting-rods, machine keys, machine rack, and a complete line of round cold-drawn steel for shafting, screw stock, etc., and cold-drawn steel in flat, square and hexagon shapes.

INTERNATIONAL ACHESON GRAPHITE CO., Niagara Falls, N. Y., announces that through an agreement entered into between the International Acheson Graphite Co., and the Acheson Oildag Co., since April 1, it has been made general agent in the United States for the sale of the lubricants, "Oildag" and "Aquadag," made by the latter. This means that the trade will in future be supplied by the International Acheson Graphite Co. with lubricants that meet all needs, inasmuch as it has been producing "Gredag."

NATIONAL MACHINE CO., Milwaukee, Wis., announces that it is having plans prepared for a new brick-and-steel machine shop two stories high, 55 by 100 feet. The first floor will be concrete and the second floor and roof, mill construction. The basement 14 by 35 feet, extending to the curb line, is to contain the heating plant and lavatories. The first floor is to be 16 feet clear, with a five-ton traveling crane to cover one-half of the shop; the second floor will clear 12 feet. Provision is to be made later for an elevator.

KELLY REAMER CO., 522 Prospect Ave., N. W., Cleveland, Ohio, at its annual meeting April 15, elected William E. Kelly, Albert H. Weed, John M. Marty, Jr., Edward B. Jessup and J. W. Strain, directors, who elected for the ensuing year, the following officers: William E. Kelly, president; Albert H. Weed, vice-president; and John M. Marty, Jr., secretary-treasurer. William E. Kelly was appointed general manager. The company reports a large increase in business, and on May 1 will move into its new quarters, No. 1547-1565 Columbus Road, N. W.

OTTO GAS ENGINE WORKS, Philadelphia, Pa., announces that Mr. Frank Salomon has become its president and has taken charge of the management. Since his connection with the firm last year the whole plant has been reorganized, the results of which have shown up advantageously in the increased manufacturing facilities and greater output at less expense, thereby enabling a reduction to be made in the selling cost without reducing the high quality of goods produced. Mr. Salomon's attention is now being directed to the sale organization, and in addition to the branch offices already established, new ones are being planned.

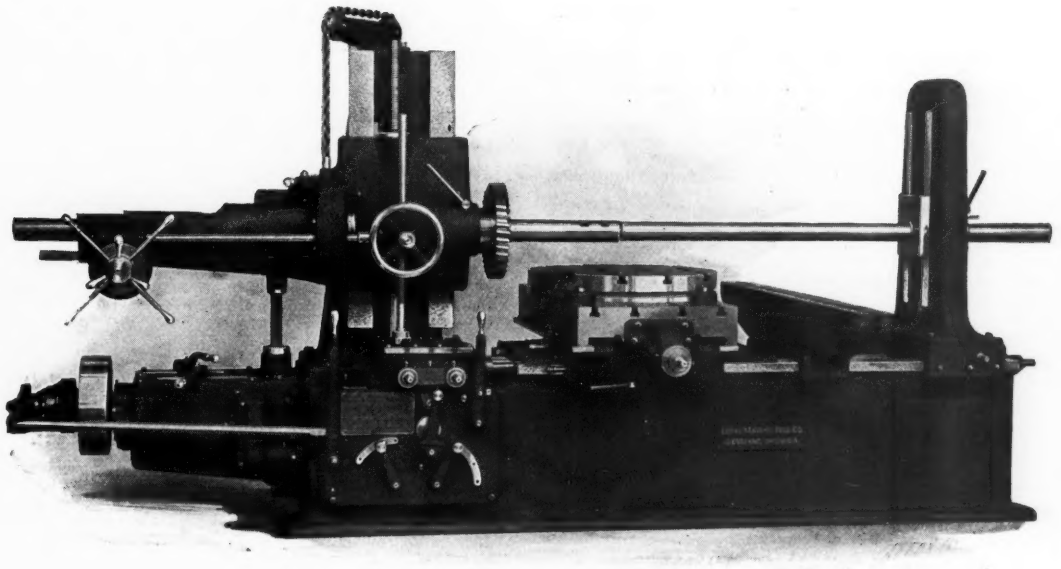
OHIO MACHINE TOOL CO., Kenton, Ohio. A controlling interest in the company has been purchased by Walter D. Sayle, president of the Cleveland Punch & Shear Co., and C. C. Swift, of Cleveland. The new officers are: W. D. Sayle, president; H. W. Granlich, vice-president; C. C. Swift, secretary and treasurer; and W. D. Smith, superintendent. Mr. Swift is also general manager. The well-known line of planers and shapers made by the company will be improved, and the present plant will be improved by the addition of considerable new equipment, which will greatly increase the capacity. Mr. Swift, the general manager, has had a wide experience in the machine tool trade and Mr. Smith, the superintendent, is the designer.

COLBURN MACHINE TOOL CO., Franklin, Pa., furnished a 42-inch vertical boring and turning mill for the machine shop equipment of the United States naval repair ship, *Panther*, when the battleship fleet made its famous round-the-world voyage three years ago. The machine was shipped to San Francisco early in June, 1908, but failed to reach its destination in time, and the *Panther* sailed without its boring mill. The machine was installed at the Mare Island Navy Yard and has been in use ever since. Another Colburn boring mill, 54 inches capacity, weighing 30,000 pounds and driven by a ten horsepower motor, has been ordered for the *Panther* and will be installed in the vessel at the Brooklyn Navy Yard, where she is now being overhauled and fitted.

NEW DEPARTURE MFG. CO., Bristol, Conn., manufacturer of a high-grade line of specialties, including a complete line of ball bearings, opened a Western branch at rooms 1016-1017 Ford Bldg., Detroit, Mich., April 15. This company will maintain an engineering and sales force at this branch which will be immediately available to the many customers in Detroit and the West. Secretary Page invites all of the trade to make their headquarters at the branch office when in Detroit. Stenographic, telegraphic, telephonic and other conveniences have been provided especially for guests. A full stock of all bearings of the company's manufacture will be carried at the branch. All the important engineering data that have been accumulated by the company at the home office will also be on file.

HOOPER-FALKENAU ENGINEERING CO., 165 Broadway, New York, has recently been formed to take over the business of Mr. George K. Hooper, designer and organizer of industrial plants. Mr. Hooper's experience covers a period of twenty-five years in various capacities from unskilled labor to executive and consulting engineer. Mr. Falkenau was formerly with the Falkenau-Sinclair Machine Co., of Philadelphia, Pa., of which he was president for a number of years. In the course of thirty years' experience as consulting engineer and

EVERY man who pays his bills has to pay also for those who do not, and by the same token every man who buys an inferior machine has to pay for repairs and the time it is idle during repairs



"NOT A CENT FOR REPAIRS IN FIVE YEARS"

is the usual report of the users of the

"PRECISION"

Boring, Drilling and Milling Machine

Don't be one of those who cannot see the coal when it runs to waste out of a leaky hot water faucet.

Lucas Machine Tool Co.

Cleveland, Ohio, U. S. A.

AGENTS—C. W. Burton, Griffiths & Co., London. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Bilbao, Barcelona. Schuchardt & Schutte, Berlin, Stockholm, St. Petersburg, Copenhagen. Donauwerk Ernst Krause & Co., Vienna and Budapest. Overall, McCray, Ltd., Sydney, Australia. Andrews & George, Yokohama, Japan. Williams & Wilson, Montreal.

owner of machine works Mr. Falkenau has best become known as the designer and perfecter of many successful devices, principal among which is the pneumatic system for handling mail. The new firm will carry on the same class of work as heretofore done by the individual members.

PORTER-CABLE MACHINE CO., Syracuse, N. Y., states that the difficulty usually experienced by draftsmen in selecting the proper division mark on a scale divided into sixty-fourths or hundredths, due to the maze of lines presented to the eye, has been overcome by its simple segregated scale. In the April number an unfortunate error occurred in the advertisement of the scale on page 84; the expression, "sixty-fourth hundredths" was used, whereas it should have read, "sixty-fourths or hundredths." It is hardly likely any readers of MACHINERY were confused by this new hybrid term, as the meaning was so apparent. The scale, which was given a full description in the department "New Machinery and Tools" in the March number, is die-stamped on the finest bristol-board, and, having each dimension entirely independent of all the others, is very useful for rapid scaling.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS at its meeting in New York, April 11, had a very interesting paper on the "Economic Importance of the Farm Tractor," by L. W. Ellis. Following this paper Dr. Chas. E. Lucke, professor of mechanical engineering at Columbia University, gave a talk on the mechanical equipment of the farm tractors, which he illustrated by views taken at the Canadian Industrial Exhibition held in Winnipeg, Man., last summer where Dr. Lucke represented the International Harvester Co. Mr. Ellis, who is a traction plow specialist for the M. Rumely Co., La Porte, Ind., believes the farm tractor to be the solution of the immediate problem of providing for deeper plowing and better tillage. He pointed out that increased production for practical reasons depends upon animal power. The horse is capable of little further improvement in economy, while the actual refinement of the tractor has scarcely begun. Mr. Ellis gave the results of a number of tests made to discover the coal, water and gasoline consumption of production and operation: these point to relatively high economy and superior results of mechanical power.

MISCELLANEOUS

Advertisements in this column, 25 cents a line, ten words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

ABOUT SPECIAL TOOLS, DIES, JIGS, fixtures and light machinery —we make them. Do you want estimates? Mail blueprints or sample to D. W. BARTON CO., Elizabeth, N. J.

AGENTS IN EVERY SHOP WANTED to sell my sliding calipers. Liberal commission. ERNST G. SMITH, Columbia, Pa.

AGENTS wanted in every works in Great Britain where draftsmen, machinists and tool-makers are employed, to represent MACHINERY and take orders for MACHINERY'S remarkably successful Reference Books. Special offers in force in Great Britain for a limited time only, give a choice of 65 Reference Books and 20 new Data Books sold at a shilling per copy, and a subscription for MACHINERY, cash or credit. No charge is made for credit. We supply sample copies and advertising matter describing the books in detail for distribution in Engineering Works. Write us for full information. WM. DAWSON & SONS, LTD., Cannon House, Bream's Bldgs., London, E. C.

A THOROUGHLY WELL EQUIPPED MACHINE TOOL SHOP, having accumulated considerable of its own product, and desiring to employ its full organization, is open for work of good class, and solicits contracts from $500.00 to $50,000.00. Location, Central West. Address box 372, care MACHINERY, 49 Lafayette St., New York.

BOOKS.—"Dimensions of Pipe, Fittings and Valves," 75c.; "Lettering," 25c. NATIONAL BOOK CO., Collinwood, Ohio.

BORING MILL OPERATOR WANTED for Niles horizontal. Conditions and pay good. DEANE STEAM PUMP CO., Holyoke, Mass.

DRAFTSMEN AND MACHINISTS.—American and foreign patents secured promptly; reliable researches made on patentability or validity; twenty years' practice; registered; responsible references. EDWIN GUTHRIE, Corcoran Building., Washington, D. C.

ENGINEERING, DESIGNING, PHYSICAL AND CHEMICAL TESTS OF MATERIALS.—We are Specialists in automobile design, internal combustion motors for all purposes and power applications. We test and report on motors, mechanism and manufacturing projects, design and detail from your ideas, and, if desired, build and test the first machine. Strict privacy for such work. Do you want a specialty to manufacture? LANDAU & HOWE, Engineers, 1781 Broadway, New York.

EXPERT DESIGNING—IDEAS DEVELOPED by a practical manufacturer. Tool equipment for the manufacture of metal goods a specialty, also power plant arrangement. Best results assured. Lowest prices. Address Lock Box 41, Indianapolis, Ind.

FIRST-CLASS MAN to take charge of the operation of Bevel Gear Planers and Spur Gear Cutters. To a man who can produce good results, an excellent position is offered. Address box 375, care MACHINERY, 49 Lafayette St., New York.

FORMULAS AND TABLES FOR SHOP AND DRAFTING ROOM is No. 35 in MACHINERY'S Reference Series, and for practical use in mechanical work is undoubtedly the most widely technical useful book published in years. Send for free pamphlet with new offers. Address MACHINERY, 49 Lafayette St., New York.

FOR SALE.—One second-hand 8½ x 16" Potter & Johnston Automatic Chucking and Turning Machine, in use for just four years, and having had the best of care is in very good condition. Has standard 3 9/16" spindle, triple geared automatic change speed head, heavy cross-slide, oil pump and oil pan base. The machine is fitted with a special draw-back bar and hand lever for operating expanding collet arbors through the spindle, somewhat similar to the backfacing attachment. The backfacing attachment sometimes supplied with these machines could quite easily be fitted to it. Weight, 8000 lbs. Address box 371, care MACHINERY, 49 Lafayette St., New York.

FOR SALE.—Small patented machine; will stand investigation. Address box 370, care MACHINERY, 49 Lafayette St., New York.

FULLY EQUIPPED FOUNDRY AND MACHINE WORKS would like to communicate with concerns that have specialties to manufacture. We wish steady work and moderate profits. Box 413, Gloversville, N. Y.

HIGH GRADE SPECIALTY MANUFACTURERS.—We are in position to give you a very low price on screw machine and punch press work, special machinery, tools, etc. Also develop your ideas, make models, and do your experimental work. Give us a trial. HILL & SACKMAN, 131 Wall St., Cambridge Springs, Pa.

LIGHT MACHINERY WORK done accurately and carefully from start to finish. Expert advice. Ideas developed and worked out. Address Box 364, care MACHINERY, 49 Lafayette St., New York.

LIGHT MANUFACTURING WANTED.—An established concern with a first-class plant and full equipment of modern machinery, would undertake the manufacture and marketing of any light machine tool, or special line of machines. Exceptional facilities. A-1 work guaranteed. Address with full particulars, BOX 188, CONNEAUT, OHIO.

PATENTS.—H. W. T. JENNER, patent attorney and mechanical expert, 608 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had and the exact cost. Send for full information. Trademarks registered.

POSITION WANTED.—Young man with experience in drafting room and machine shop, desires position in drafting room. Address E. W. B., care MACHINERY, 49 Lafayette St., New York.

POSITION WANTED.—GRADUATE MECHANICAL ENGINEER, nine years' general experience, five years with air compressor builders, design, testing, development of electric driven units, special problems in air and natural gas compression, sales, engineering and publicity work; wants responsible position with compressor builders. At present employed. Address box 373, care MACHINERY, 49 Lafayette St., New York.

POSITION WANTED AS DRAFTSMAN by young man, correspondence student, willing to start at the bottom. Address box 369, care MACHINERY, 49 Lafayette St., New York.

POSITION WANTED BY EXPERIENCED CHIEF DRAFTSMAN who has had charge in the designing of large pumping engines, mining engines, boilers, marine engines and marine turbines. First-class references. Address box 361, care MACHINERY, 49 Lafayette St., New York.

SALESMEN WANTED in all manufacturing localities, to handle line of machinery safety devices on commission. Can be handled as side line. Unlimited field. Best references required. Address box 374, care MACHINERY, 49 Lafayette St., New York.

STEAM ENGINE DESIGNER capable of taking charge of room, desires responsible position. Wide experience on steam engines, also tool machinery; long practical experience, technical education abroad; at present employed. Address A. B., care MACHINERY, 49 Lafayette St., New York.

TELESCOPIC OIL-STONE HOLDER; 25c. F. J. BADGE, 286 Taaffe Place, Brooklyn, N. Y.

TEST INDICATORS.—H. A. LOWE, 1374 East 88th St., Cleveland, Ohio.

WANTED.—Agents, machinists, toolmakers, draftsmen, attention! New and revised edition Saunders'. "Handy Book of Practical Mechanics" now ready. Machinists say "Can't get along without it". Best in the land. Shop kinks, secrets from note books, rules, formulas, most complete reference tables, tough problems figured by simple arithmetic. Valuable information condensed in pocket size. Price postpaid $1.00, cloth; $1.25, leather with flap. Agents make big profits. Send for list of books. E. H. SAUNDERS, 216 Purchase St., Boston, Mass.

WANTED.—MAN CAPABLE OF OVERSEEING ABOUT 12 MACHINISTS, and die makers; one who is experienced in the making of dies for stamping sheet metal ware and understands machinery for same. Address O, care MACHINERY, 49 Lafayette St., New York.

WANTED.—MACHINE AND PRESS WORK; tools, dies, jigs and machines built to order. THE G. M. DIEHL MACHINE WORKS, Wabash, Ind.

WANTED.—Young man experienced in making layout drawings of tools for steel stampings and pressed metal, under the direction of an engineer. Must be rapid, accurate and thorough. In reply state experience, etc., and salary required. Address ENGINEER, box 25, care MACHINERY, 49 Lafayette St., New York.

WANTED.—Applicants for Cadillac Motor Car Co.'s Instruction Department Course. Only those will be considered who are 18 years old and over, do not use cigarettes or intoxicating liquors, and who are willing to go through the entire two-year course, which consists of eight shop departments, tool drafting class work, and also day work. There is no auto repairing or driving given in this course. Apply between 1:30 and 2:30 P. M. CADILLAC MOTOR CAR CO., 1343 Cass Ave., Detroit, Michigan.

WANTED.—CHIEF DRAFTSMAN. Applicant must have good experience in all branches of designing for shop manufacturing heavy saw mill machinery. Address box 376, care MACHINERY, 49 Lafayette St., New York.

WANTED.—HIGH GRADE MECHANICAL SUPERINTENDENT for machinery manufacturing plant. Must be first-class mechanic and manufacturer. State experience. $5,000.00 or more to right man. Address box 368, care MACHINERY, 49 Lafayette St., New York.

WANTED.—ASSISTANT FOREMAN in factory manufacturing instruments of precision in quantities, by interchangeable methods. Applicant must be sober, of good character, up-to-date, versed in modern system of manufacture and have served in a similar capacity before. Give age, nationality, whether single or married, salary expected and references, which are strictly confidential. Attractive and steady position for the right party. Address box 367, care MACHINERY, 49 Lafayette St., New York.

WANTED.—FIRST-CLASS TOOL AND JIG DESIGNER for large Automobile Concern in Ohio. Must be up-to-date on modern methods and come well recommended. Address, stating particulars and wages expected in first letter, box 366, care MACHINERY, 49 Lafayette St., New York.

WORKS MANAGER WANTED.—An old established and well organized company, employing about one thousand men, and manufacturing a high class product, wishes to secure a capable Works Manager, of large experience in the production of small and accurate mechanisms, such as adding machines, typewriters, firearms, etc. Man under 40 years of age preferred. Applicants are requested to give their experience in full, state age, positions occupied, and furnish list of references. To the right man a permanent position is assured, at liberal salary. Location, New York State. Address "ACCURATE EXECUTIVE," care MACHINERY, 49 Lafayette St., New York.